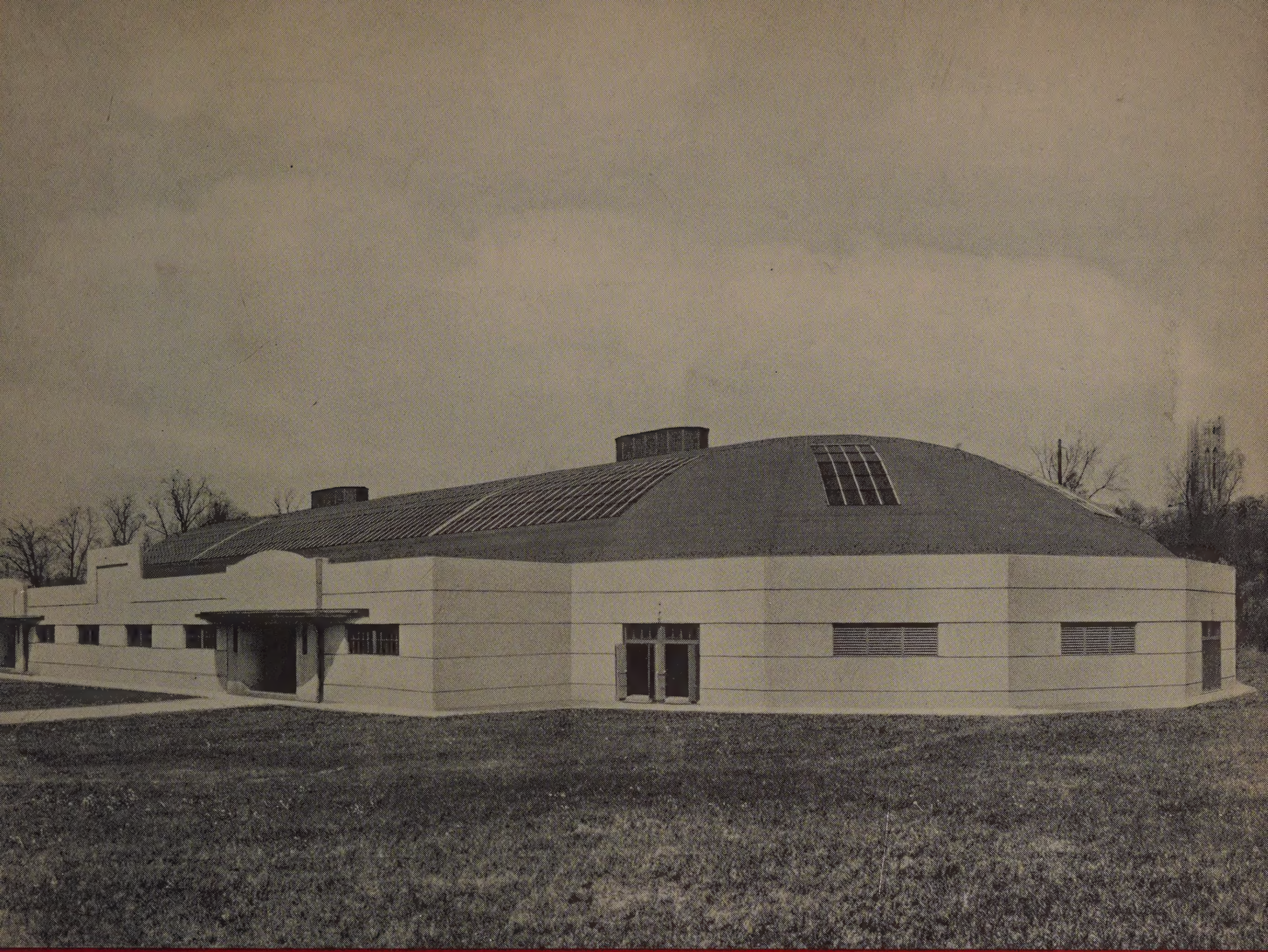
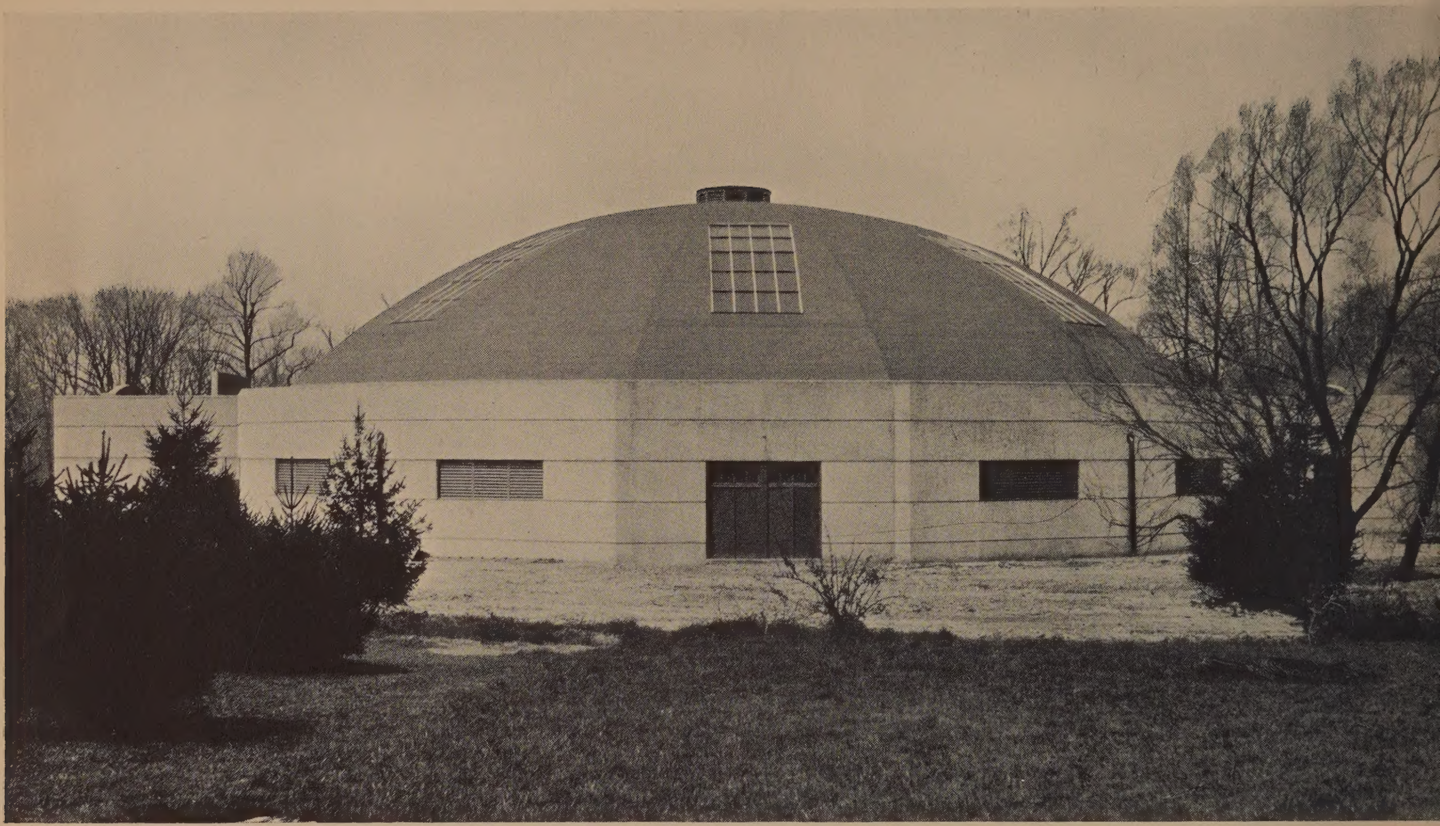


ARCHITECTURAL CONCRETE

VOLUME TWO NUMBER TWO



SWARTHMORE COLLEGE FIELD HOUSE

Philadelphia, Pa.

Karcher & Smith, Architects

Robert E. Lamb, Designer

Hughes-Foulkrod Co., Contractor

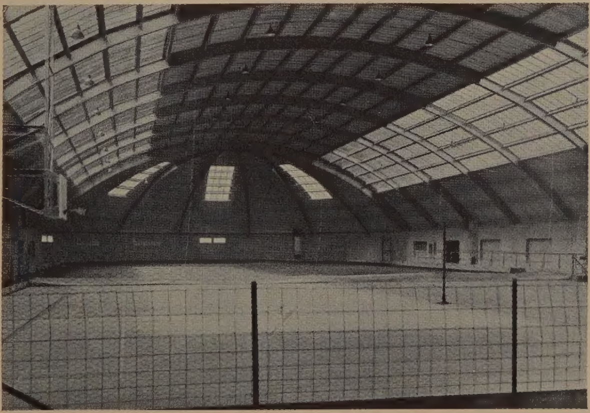
A huge coverea playing field for year-'round sports, this new field house (see cover also) is the first large structure of its kind in Middle Atlantic states. How to execute this design in concrete to harmonize with older stone buildings on the campus was the main problem, solved finally by the use of local sands and aggregates having desired color properties.

Architectural CONCRETE

Swarthmore College Field House

THE Field House has become an increasingly important addition to American college and university athletic equipment. It represents not the much discussed "over-emphasis" of collegiate sport spectacles, but rather an extension of athletic and health facilities for the use of all the campus residents. It can shelter many different sports simultaneously, and on rainy days and during winter it becomes the center for what used to be considered outdoor games. For a field house, properly, is a covered field in which baseball, tennis, track and field events, football, basketball and other intercollegiate and intramural sports may be played in all seasons—good weather or not. And when athletics lag, the field house becomes an auditorium, a convention hall—a utility building adaptable to a hundred different activities.

Swarthmore College Field House is the first large structure of its kind to be built by any college in the central eastern states. It is a large building of rather unique design, 326x175 ft. in plan, with semi-circular ends. An arched roof spanning the playing field has an extreme clear height of 41 ft. It contains a cinder track 1/7 mile in length, space on wood flooring for two regulation basketball courts or two tennis courts, a dirt floor regulation-sized baseball diamond usable also as a football or lacrosse field. In addition to this playing area, there are various accessory rooms such as students' lockers, shower rooms, lavatories, entrance lobbies, wrestling rooms, offices and separate shower and dressing rooms for home and visiting teams.



Football, baseball, track—ample space for almost any sport.

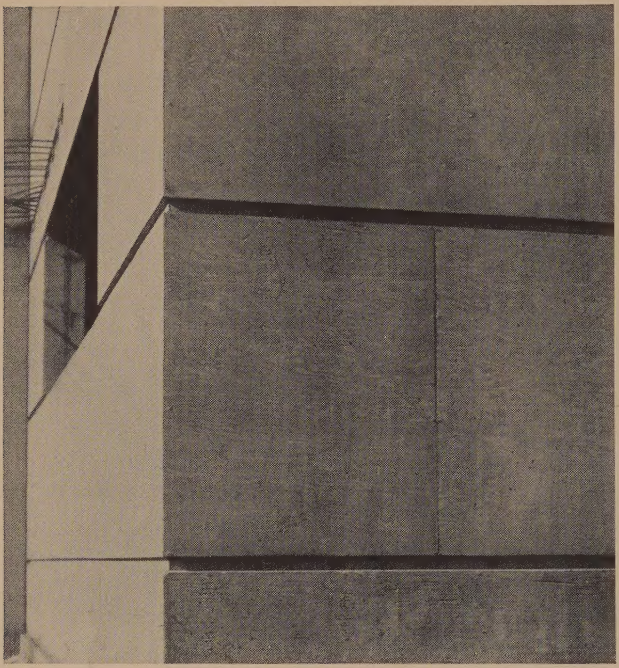
When it was decided that Swarthmore should have a new field house, there was considerable discussion relative to the type of construction that would be used. Economy carried great weight in these discussions. It was the desire of the college officials to build as large a covered playing field as possible with funds available, but the high architectural standard of the other buildings on the campus had to be maintained.

Architectural concrete appeared from the first to be the logical material from the standpoint of economy, but the idea of frankly using concrete as the architectural medium would never have become a reality if the trustees and the architects had not been convinced that a concrete building would be in harmony with the rest of the campus.

Every one connected with the project was confident of the ability to produce a highly satisfactory structural job, but there was the question: how could the normal grey color of concrete be made to harmonize with the warm pink and buff tones of the Foxcroft stone of which the other buildings were constructed? The problem was solved very inexpensively.

How the desired permanent color effect—a buff and pink-toned concrete—was obtained is an interesting example of the adaptability of architectural concrete.

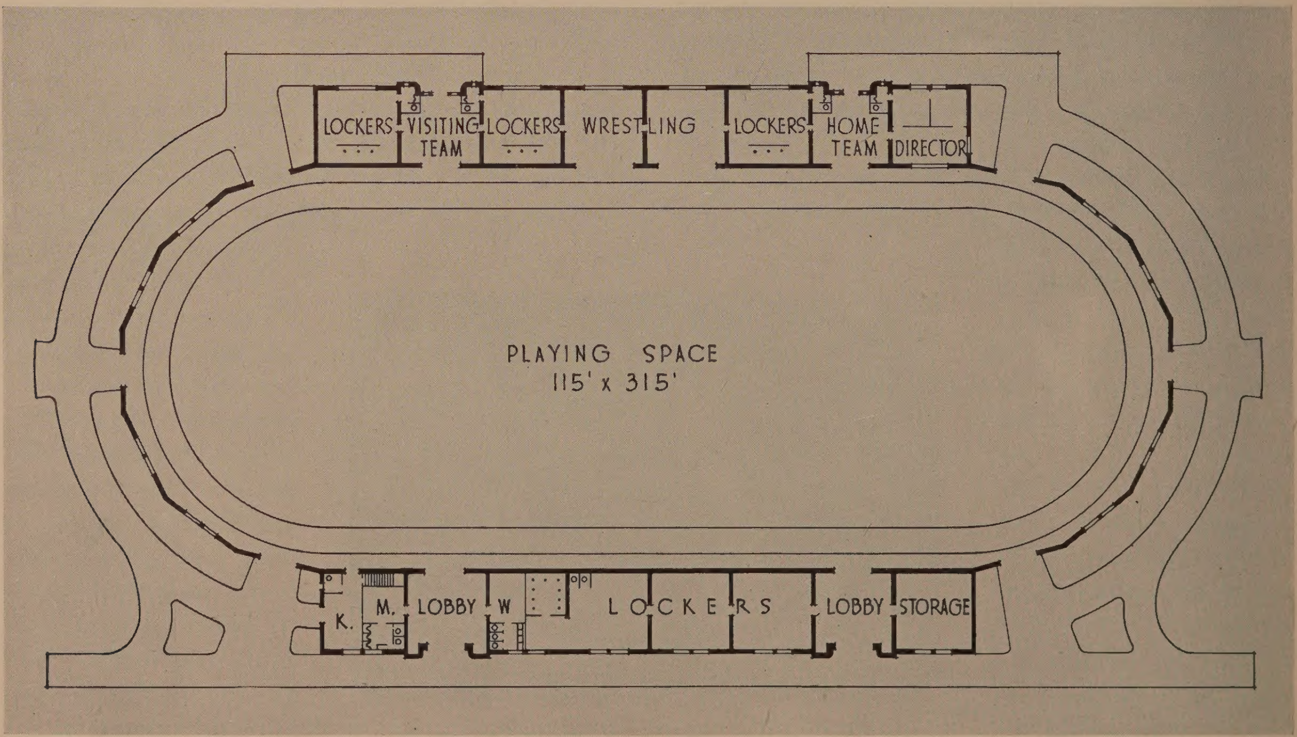
Several sample concrete panels were prepared, using various local sands and aggregates having definite color qualities. The best looking sample, and the one finally adopted, comprised light-colored cement, commercial Jersey gravel and crushed gneiss to which was added a small amount of hematite bearing clay from the Potasco deposit near Baltimore. This pigment clay, reduced to a consistency of lime putty, was thoroughly dispersed through the concrete mix, producing in the finished panel a uniform color.

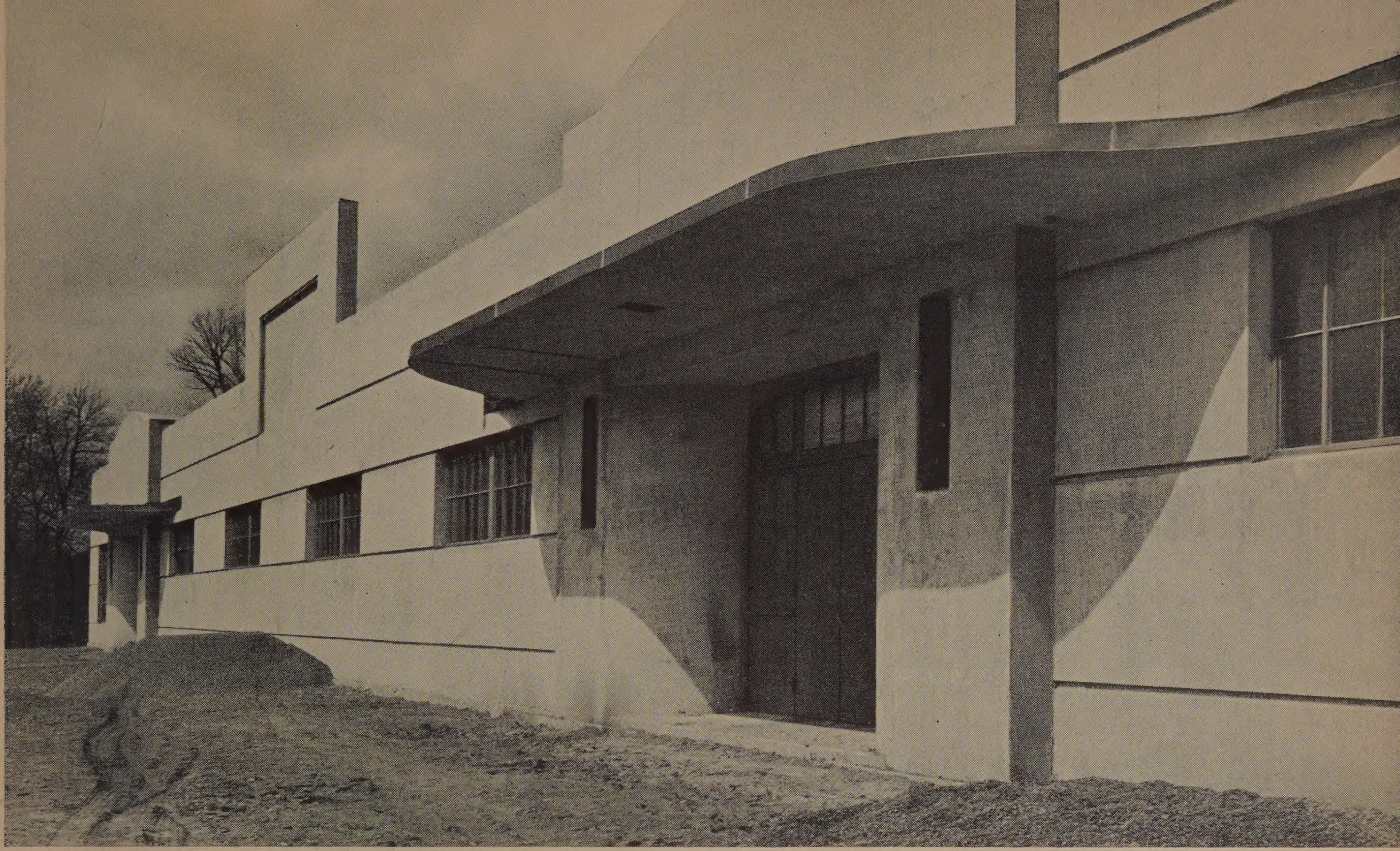

Walls were formed against large plywood panels which lend their smooth, grain-marked textures to the concrete.

The concrete was mixed in the proportion of 1 part portland cement, 2½ parts sand and 3½ parts coarse aggregate. Mixing was done in a four-bag mixer, each batch containing about 27 lb. of the hematite bearing clay paste, composed of 4½ lb. clay and 2½ lb. water.

Exhaustive tests were then carried out with the concrete samples for strength and workability; and when satisfactory results were obtained, final decision was made to proceed with the structure in architectural concrete. Uniformity of color throughout the job was readily obtained by accurate proportioning, thorough mixing and careful spading of the concrete in the forms. The crystalline structure of the gneiss coarse aggregate shows in a sprinkling of minute crystals in the concrete which reflect light and give a remarkable degree of life to the surface.

Realizing that good appearance of concrete surfaces largely depends upon accurate formwork, special care was taken in designing and erecting the forms. For exterior walls, plywood panels in 4-ft. widths were used. The concrete was placed in three courses, 8 ft., 4 ft., and 8 ft. high, the joints being concealed by rustication lines running





The "streamline" design of Swarthmore Field House is emphasized by horizontal rustications and the fin-like canopies over the entrance portals.

around the structure, giving an interesting "streamline" effect. The wide, horizontal bands produce an effect of massiveness in keeping with the scale of the structure.

In a monolithic structure of this size, provision must be made for expansion and contraction. This was done by making two vertical joints through the structure in foundations, walls and roof. Slip joints were provided for the reinforced concrete roof beams over the flat portions of the roof, and the steel arched roof was designed to permit movement in a similar manner. All expansion joints were protected with sheet copper and caulked with asphalt filler.

An interesting feature of the Swarthmore Field House is the absence of windows in the walls adjacent to the playing area of the building. All light is provided through skylights, of which there are two major ones, each 200x25 ft. in area. These skylights are fixed and ventilation is provided through louvers in the side walls, at the ends of the building, and through two large louver ventilators in the roof. The playing field is amply lighted, since the window areas in the roof comprise about 25 per cent of the floor area. The skylights, made of actinic corrugated wire glass, diffuse the light so there is no glare in the building even when the sun shines brightly and directly through the windows.

The roof sheathing, as has been stated, is carried on steel arches resting on the concrete walls. The remainder of the structure is reinforced concrete, of which some 640 cu. yd. are used in the exterior walls alone.

Architects for the field house were Karcher and Smith of Philadelphia. Hughes-Foulkrod Co. was the general contractor. The field house was conceived by Robert E. Lamb, Chairman, Building Committee, Swarthmore College Board of Trustees.

From the mixer placed in the center of the job, concrete was conveyed by crane to the forms in large buckets. The walls were placed in 4-ft. courses.

New Schools in San Francisco

Near Completion of $3,500,000 Building Program

EARLY in the spring of 1934, the city of San Francisco approved a $3,500,000 bond issue providing for the erection of nine new school buildings and modernization of two older structures. This program was part of the larger, long-time plan by which San Francisco has kept its school system progressively in step with the need for new educational facilities.

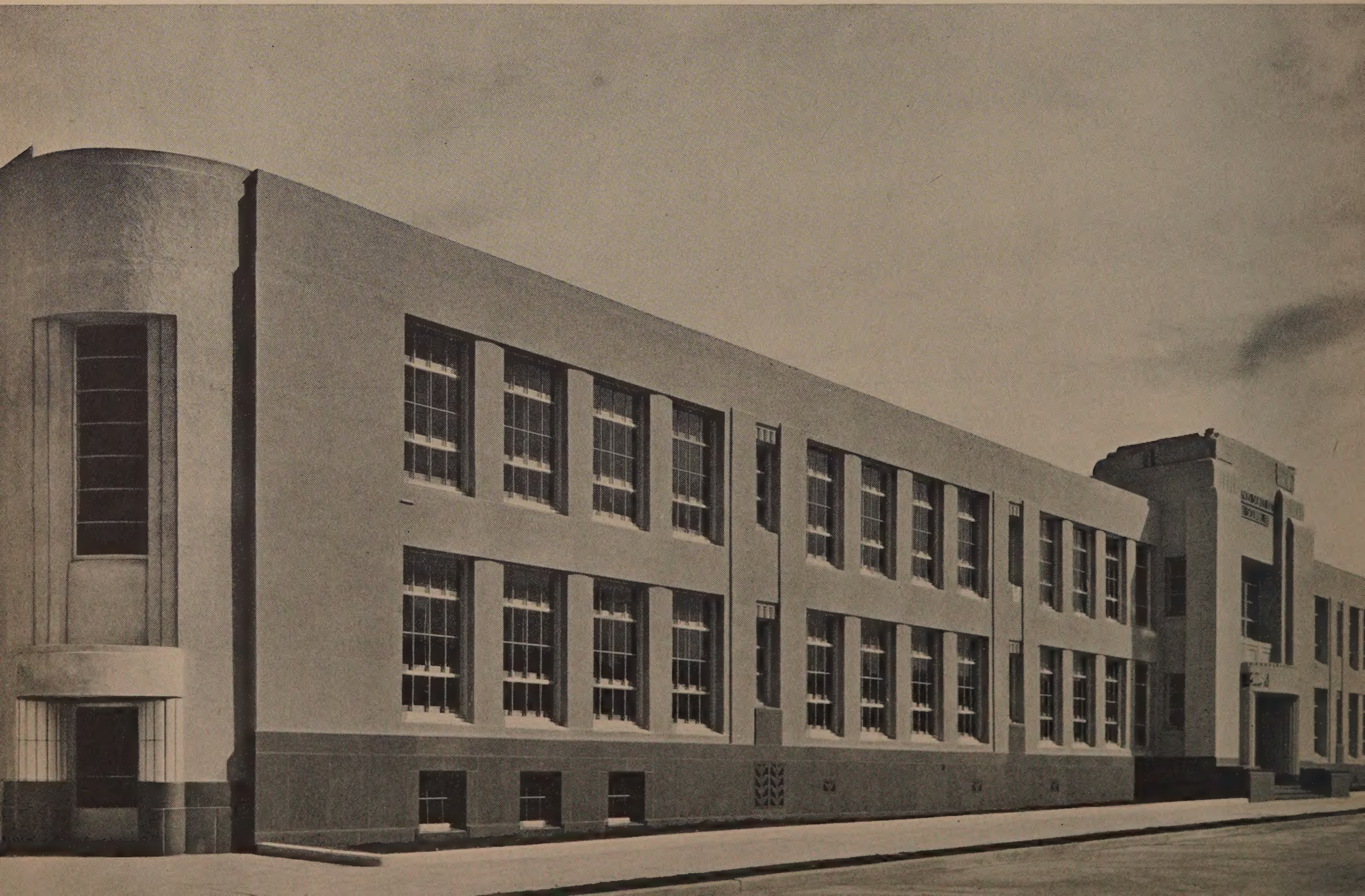
The job of designing these new schools, the educational requirements of which had been carefully planned in advance, was given to different local architects. All this work was under the supervision and direction of Charles H. Sawyer, city architect. In keeping with previous practice, all the new school buildings were designed for reinforced concrete with architectural concrete exterior walls. This type of construction provides maximum safety in earthquakes and conforms to all requirements of the recently enacted California laws for design of school buildings.

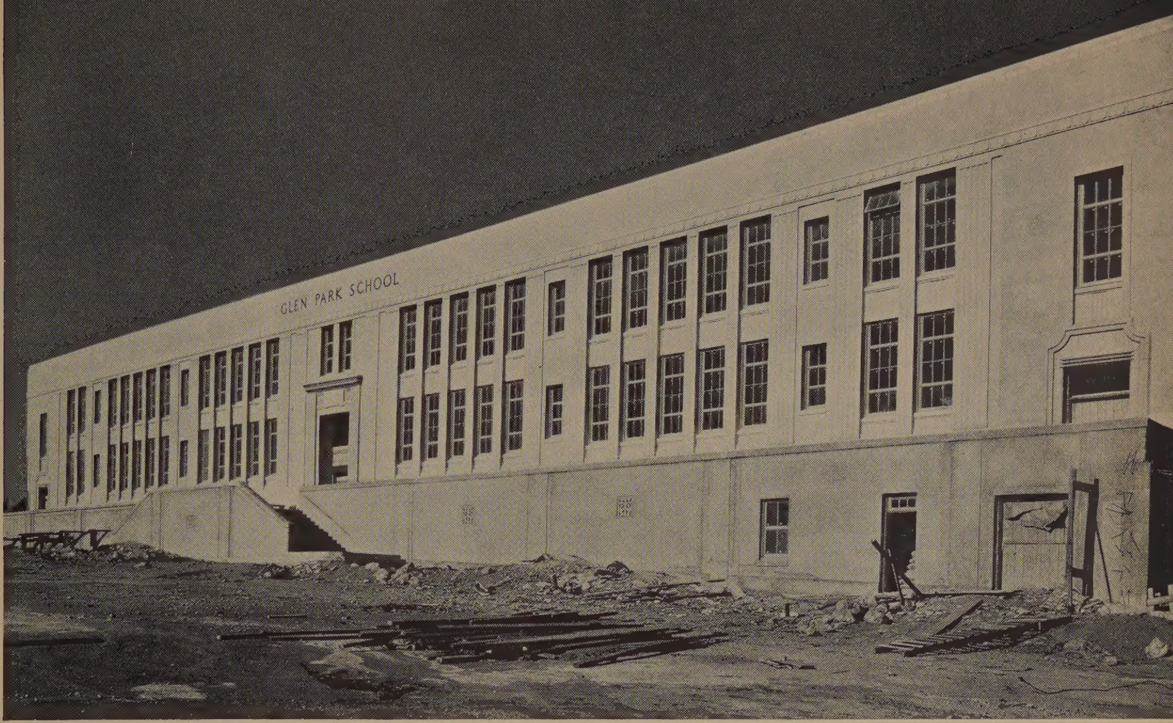
At present, all but two of the schools in the program have been completed. Their costs range from 32 to 37 cents a cubic foot—most economical for modern school buildings.

School	*Contract Price*	*Cu. Ft. Cost*
George Washington High	$734,000	$0.32
Marina Junior High	565,565	0.35
Francis Scott Key	174,600	0.37
Patrick Henry	94,397	....
Glen Park	203,978	0.32
Agassiz	126,000	....
Lawton	169,788	0.34
Visitacion Valley	162,096	0.34
Sunshine-Buena Vista	265,423	....

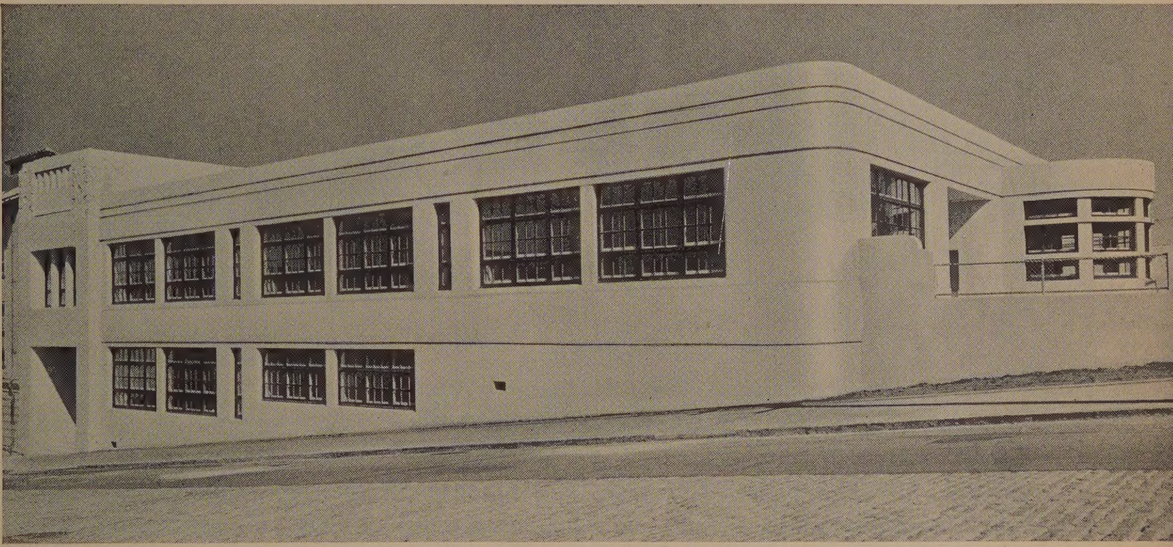
This and the following four pages comprise a portfolio of these new San Francisco schools.

Francis Scott Key School—William Mooser, Edward A. Eames and Dudley Dacre Stone, architects; James M. Smith, structural engineer; Dinwiddie Construction Co., contractor—all of San Francisco. Finish treatment is buff cement stucco.

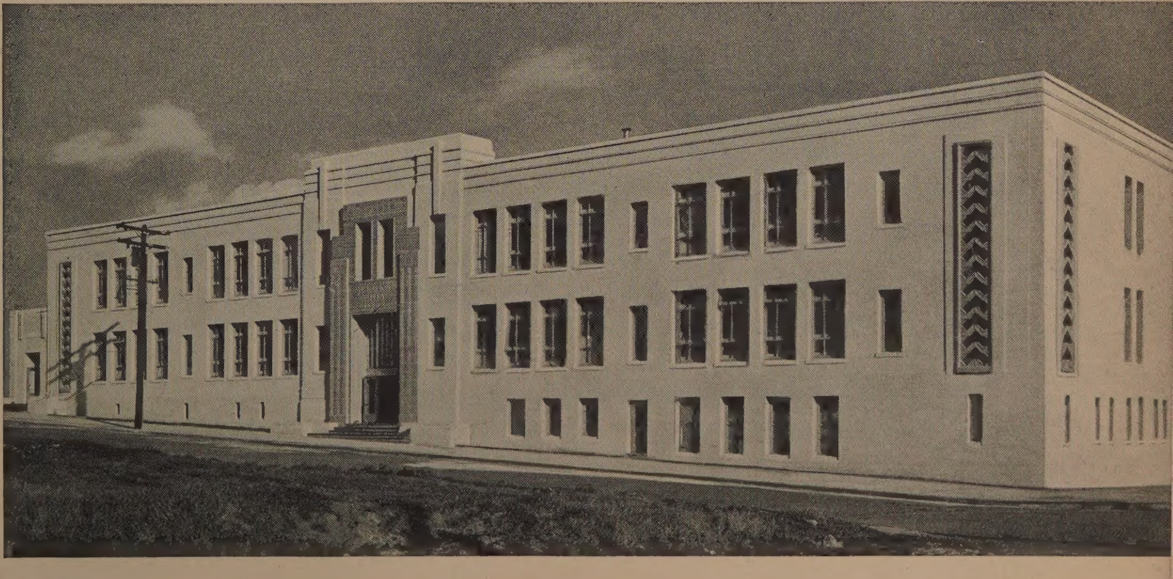




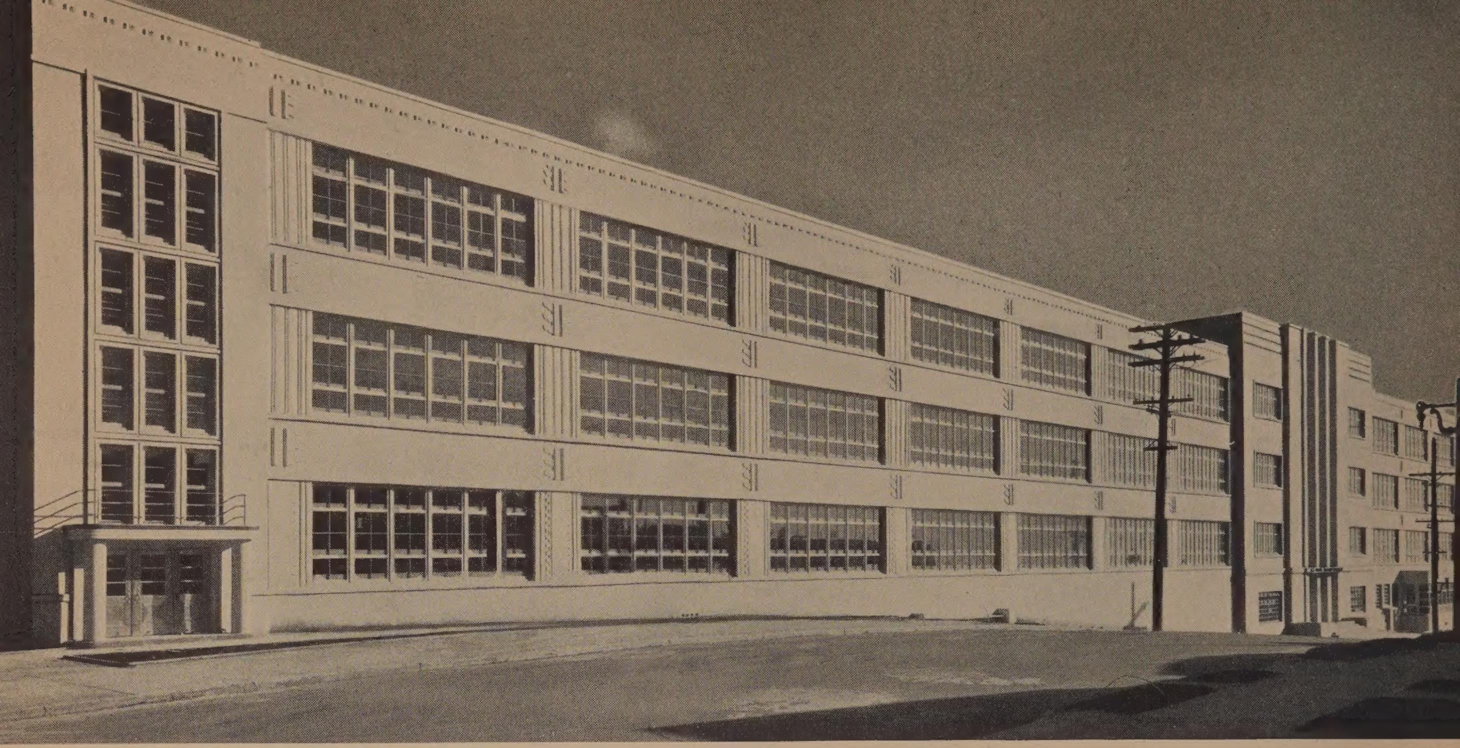
hird largest of San Fran-
sco's new schools is Glen
ark, designed by Lewis P.
lobart and Bliss & Fair-
eather. John B. Leonard,
ructural engineer and Jas.
. McLaughlin Co., con-
actor.



simply formed concrete
onolith, finished with cement
ash, is Patrick Henry
chool. Wilbur D. Peugh
nd Gardner A. Dailey,
chitects. Walter L. Huber,
gineer and O. Monson,
ntractor.



ll reinforced concrete except
rra cotta entrance and
rilles, Visitacion Valley
chool was designed by
yman & Appleton and G.
lbert Sansburgh. Kaj
heill, engineer, De Luca
nd Son, Inc., contractor.



Academic building, first unit of George Washington High School, San Francisco. Columns are arranged to permit unbroken fenestration in classrooms. Miller & Pflueger, architects; W. L. Huber, engineer and Meyer Construction Co., contractor.

George Washington High School

By T. L. Pflueger, A.I.A.

THE newly completed academic unit of George Washington High School, largest item in the current San Francisco school building program, is the first unit of a proposed $1,250,000 project. The plant, when completed, will comprise an academic unit, an auditorium seating 1,900, a shop building, separate gymnasiums for boys and girls, a football stadium for 5,000 spectators, outdoor tennis and basketball courts, baseball diamond and track field. The academic unit, subject of this discussion, cost $734,000.

As completed, the academic unit contains 45 general classrooms, 30 special classrooms and laboratories, administrative offices, library, cafeteria and Reserve Officers Training Corps quarters. The building will accommodate 2,000 pupils. Fronting 487 ft. along 32d Avenue, the structure is joined near the center by an L-shaped wing forming a south court 138x100 ft. Placed along the west property line, the building affords protection for the football stadium against ocean winds.

Three stories in height, except where descending grade on the west facade permits an additional floor, the construction is reinforced concrete. In general, the framing of the building is typical of the arrangement used in other recently constructed San Francisco schools.

Several innovations in this building make it worthy of study. The exterior columns on 32d Avenue have been spaced to permit unbroken glass areas in the classrooms, which are rather uniformly sized along this facade. This system could not be used throughout, however, because of the varying sizes of special classrooms and laboratories.

The exterior, except for terra cotta trim, is exposed concrete finished with a cement wash to preserve the quality of the concrete color and texture. Great care was necessarily taken in placing the concrete. Plywood was used for form panels and the jointing of these panels played an important part in the design. Spandrels were placed monolithically with the floor construction without horizontal construction joints at the floor levels. By eliminating these joints, the spandrel beams become continuous bands from window head to window sill and form the most important single motif of the design. There is a minimum of other ornament,

hence the quality of the exp
faces had great bearing on
ance of the building.

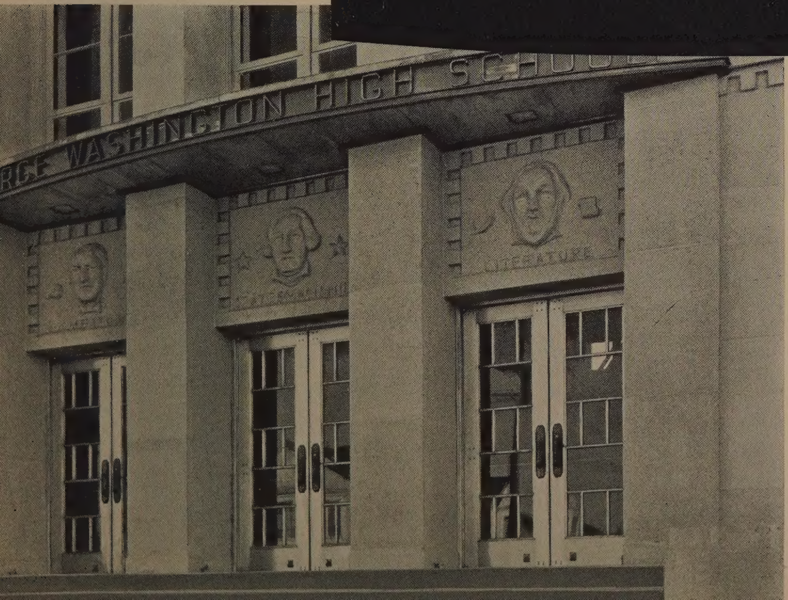
The main entrance motif
Anza Street on 32d Avenu
grally placed concrete pla
Government, the Arts an
ground floor portion is cas
the three pair of entrance d
heads of George Washingto
and Thomas Edison, represe
figures in Government, A
These bas-reliefs were cast
pared by Robert Howard
sculptor.

A particularly interestin
interior design is the main lo
wainscot of neutral tone, the
in a brilliantly colored mur
George Washington. Victor
was chosen by the architect
composition, excellent draf
murals make them an outsta
of the lobby is coffered by
and girders, with the coffers
The floor is a dark terrazzo.

Noise is minimized in all
ment of the ceilings. By fac
dents' lockers with tile units
lockers, corridor maintenanc

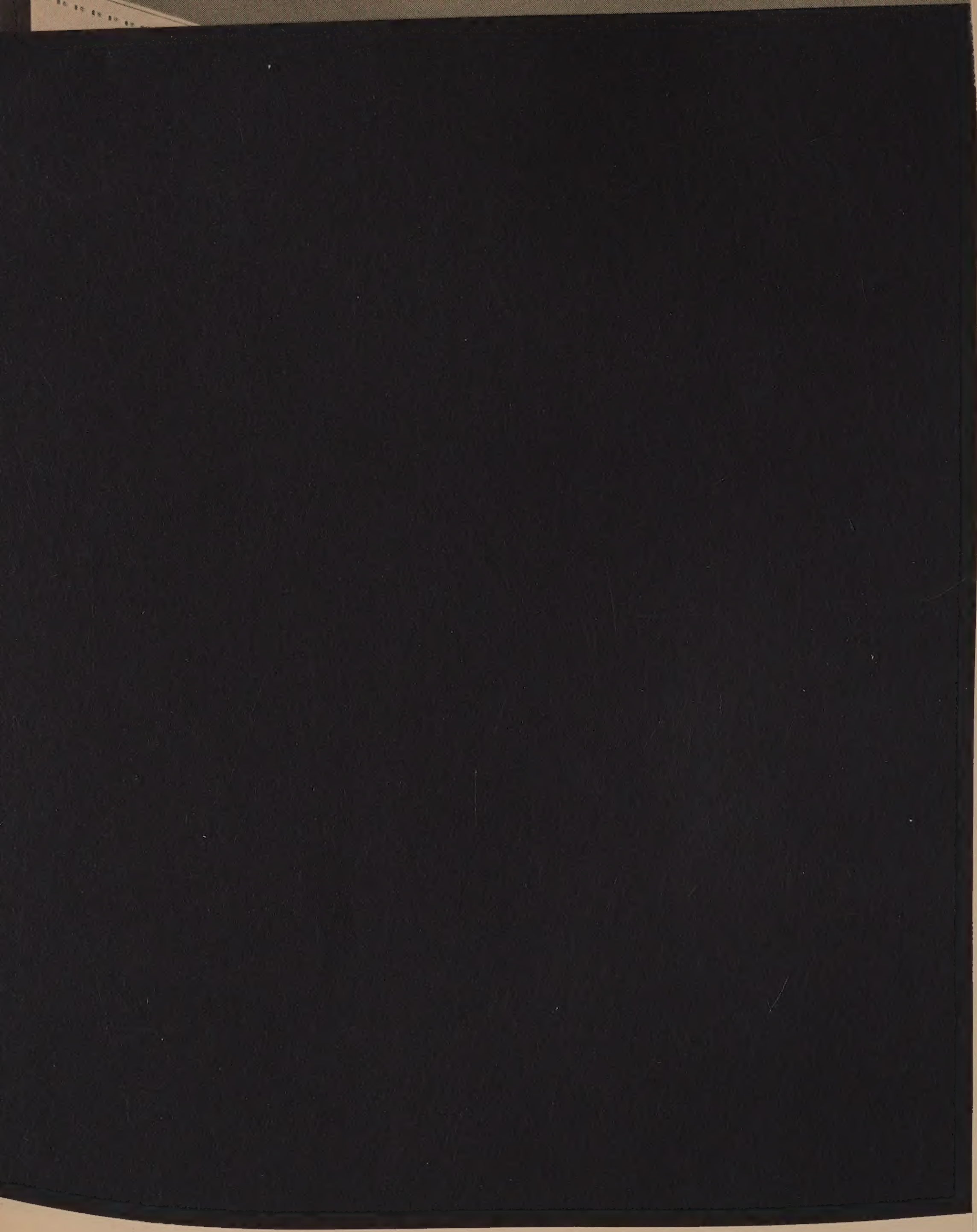
Each interior stairwell co
mitting circulation either u
dently. Walls and ceilings in
crete, with light units recess

The structural design of
when the Long Beach earthq
and legislation governing t



Leland and Haley consultants on mechanical work. The building was erected by the Meyer Construction Co., under the direction of William L. Worden, director of Public Works for the city of San Francisco and Charles H. Sawyer, city architect.

Bas-relief plaques in concrete of Edison, Washington and Whitman symbolize Science, Statesmanship and Literature.



MARINA JUNIOR
HIGH SCHOOL

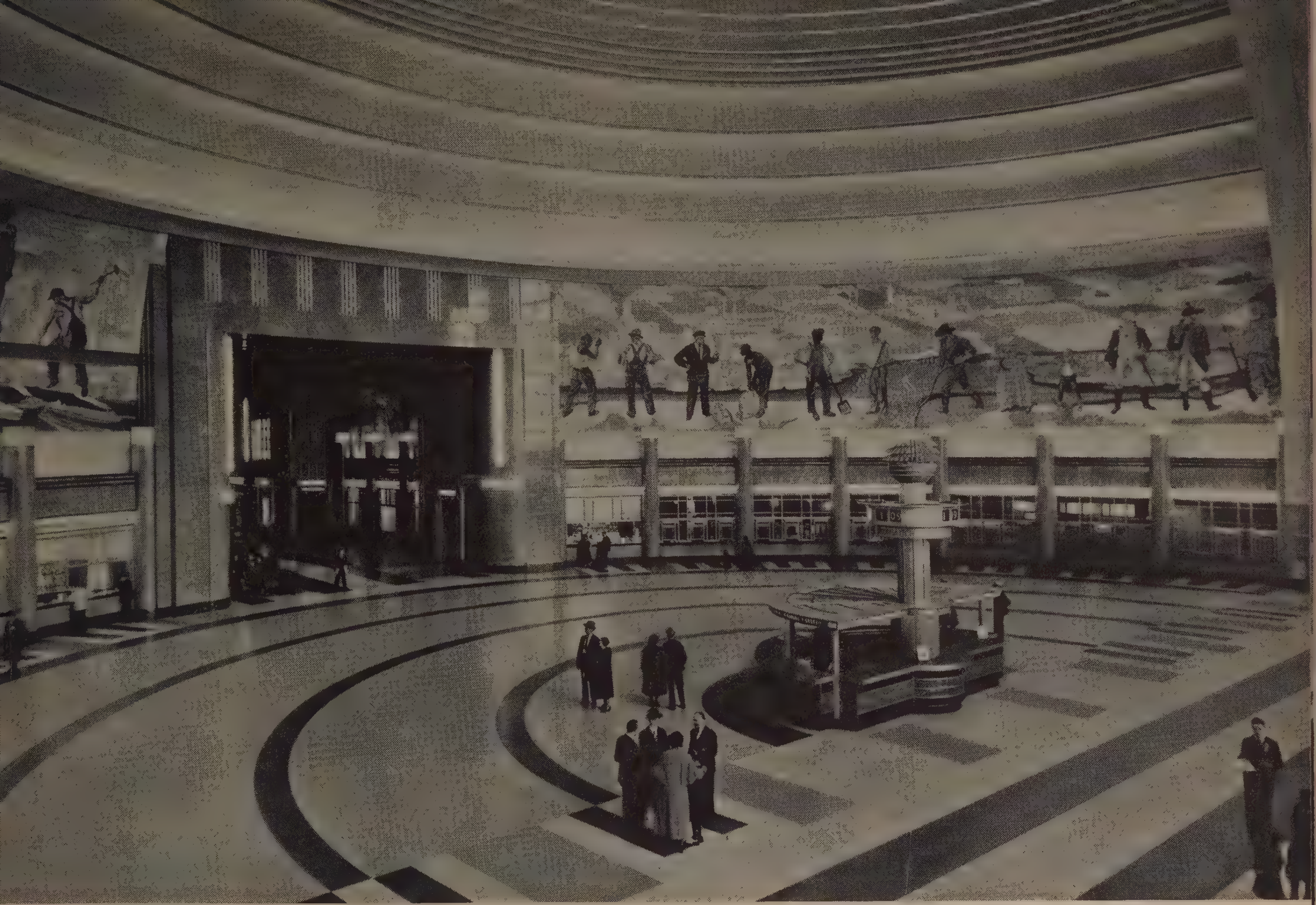
George W. Kelham and
W. P. Day, Architects

W. P. Day, Engineer

McDonald and Kahn
Co., Ltd., Contractor

SECOND largest project in the current San Francisco school program is Marina Junior High, of which two of four proposed buildings were completed recently. These structures, an academic building 315x68 ft., and a gymnasium 89x160 ft., were built at a cost of $565,000. An auditorium and a shops building, to be erected in the near future, will complete the Marina group.

Reinforced concrete, finished with portland cement stucco exterior, was used throughout. The academic building was designed as a concrete monolith, while steel frame was used for the gymnasium. Architecturally, the new Marina buildings are modern, employing strong vertical treatment to otherwise simply formed walls. Decorative detail is limited to an ornamental band around the coping, dentils over the window heads and fluted columns. Ready mixed concrete for the walls was placed in forms made of surfaced lumber.



The circular motif of the ceiling and the color of the painted walls of Cincinnati Union Terminal are echoed in the beautiful terrazzo floor. Alfred Fellheimer and Steward Wagner, architects, New York; terrazzo by Martina Mosaic and Tile Co., Cincinnati.

Color in the Floor

By A. J. Rennen*

WHATEVER may be claimed as the outstanding characteristic of current architecture, it cannot be denied that color—gay, bright, brilliant color—is becoming one of its most distinguishing features. It may be difficult to see how wide the application of color to architecture has become, for most of our new structures still tend to monochrome exteriors and have little resemblance to the free use of color that Joseph Urban visualized at the Chicago Century of Progress. Some new construction, however, has departed from the familiar browns, buffs and greys of natural colored materials to achieve color and brilliance in artificially pigmented materials. The success of these experiments makes it reasonable to predict that when more attention is given to color harmony in architecture and designers become familiar with the new color materials available, our cities will shake off their drabness and assume more happy hues.

But it is on the inside of buildings that we see the most general use of color. Brilliantly stained ceilings form harmonious backgrounds for rhythmic play of colored lights; walls gleam with pageantry executed in mural paintings on plaster; sgraffito of frankly contrasting tones contributes interesting notes of design and color; and the floors, not to be outdone despite their less decorative purpose, are patterned and marked with gaily colored designs. The effectiveness of these cheery, colorful interiors depends, obviously, upon the harmonious use of color in the ceilings, walls and floors; and the color in the floor, since the floor is the basis of all interior treatment, should be of primary consideration.

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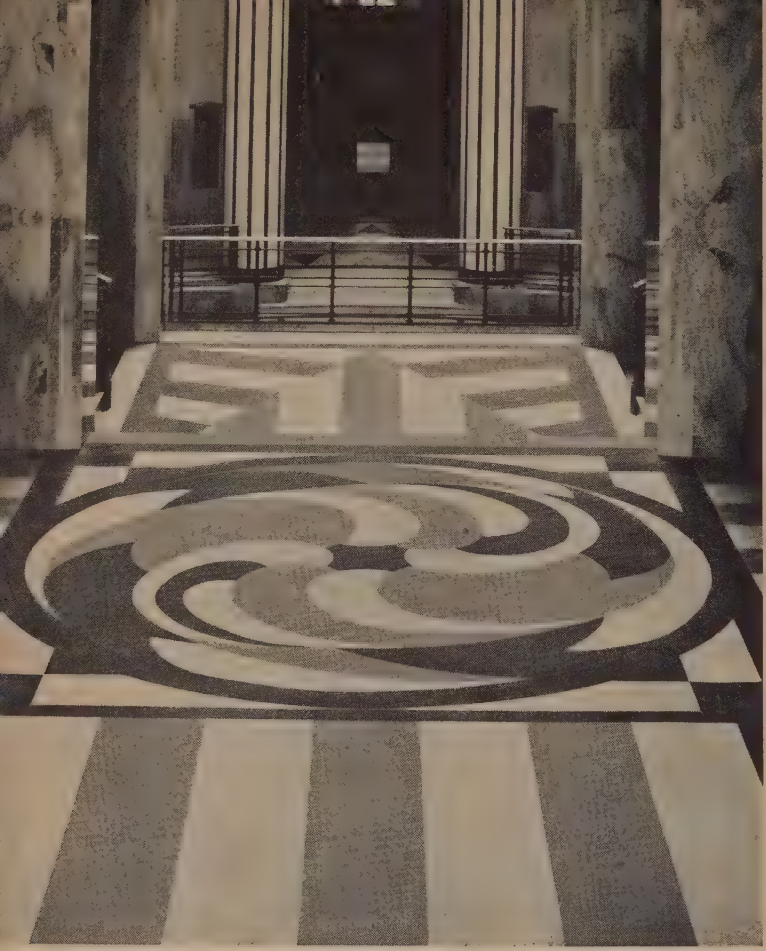
*Vice-President, National Terrazzo and Mosaic Association.



Unique pattern in terrazzo floor of Michigan Square Building, Chicago. Holabird & Root, architects; floor by Western Mosaic and Terrazzo Co.

The consistent heavy wear to which the floor of a great hall or covered concourse, such as that in the Cincinnati Union Station, is subjected, requires a permanent wearing surface to protect and preserve its color and decoration. The development of terrazzo was a long step toward the solution of the problem of economic floor construction, for it combines color and design in a permanent, durable form. The skill with which architects have used terrazzo as a fine decorative medium has proven its adaptability to any style of architecture.

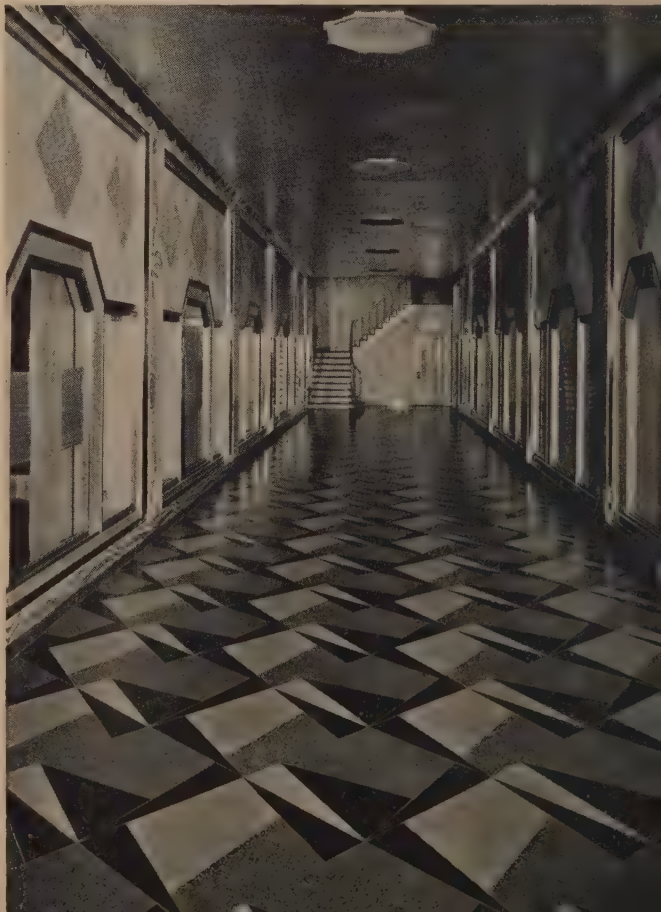
There are two methods used in constructing terrazzo floors. In one, the terrazzo finish is bonded to the concrete base, while in the other the bond is definitely broken. The latter is preferable where there is any possibility of movement in the structural slab due to expansion, or the floor is subject to vibration. A broken bond finish is slightly more expensive than a bonded finish because a minimum thickness of 3 in. is required to provide adequate strength when the terrazzo is not bonded to the base, whereas 2 in. is otherwise sufficient.

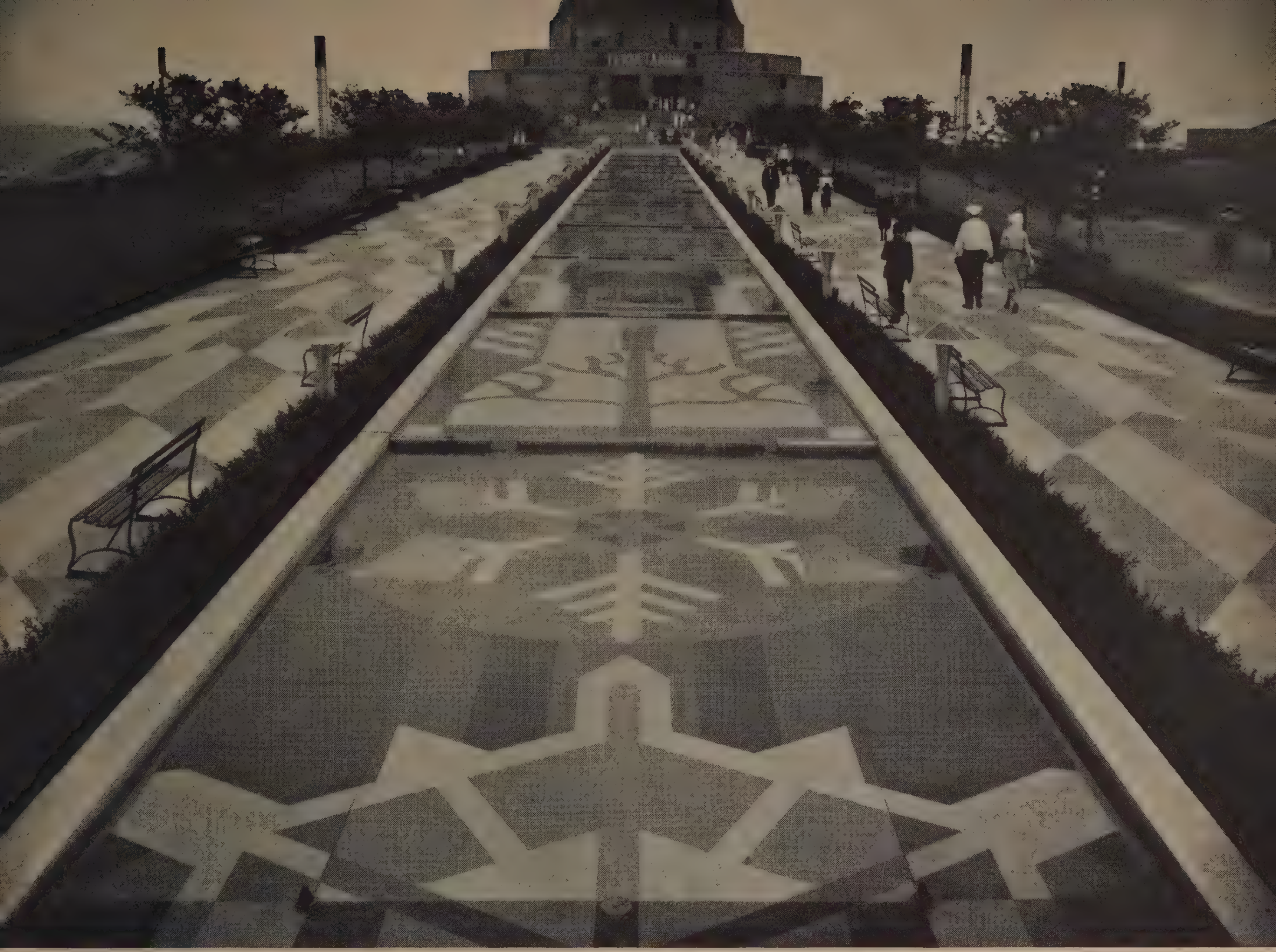
In the construction of a broken bond finish, a sand cushion ¼ in. thick is first spread uniformly on the hardened base slab. The sand provides an even bed for the terrazzo and definitely separates the finish from the base. A layer of tar paper or kraft paper is placed over the sand with the edges lapped at least 2 in. This serves to confine the sand when placing the under bed.

Over the paper the under bed, consisting of one part cement and four parts sharp, coarse sand, is placed in a layer 2 in. thick. While the under bed is still plastic, 1¼ in. wide dividing strips, usually 18 gauge brass or white metal, are set, thus outlining the desired pattern for the terrazzo. The strips are pressed into the under bed about ½ in., leaving the top edges slightly above the level of the finished terrazzo.

When the under bed has hardened sufficiently to permit rolling of the terrazzo, a mixture composed of one part white or grey portland cement and two parts marble chips or colored aggregates is placed in a layer ¾ in. thick. The cement, either uncolored or containing pure mineral oxide pigment and the aggregates, usually of three sizes—$\frac{3}{32}$-in., ¼-in. and ½-in.—are first thoroughly mixed dry and water added afterwards to make a plastic but not a wet mix. To obtain maximum clearness and brightness, especially in the lighter colored terrazzo, white portland cement or a mixture of white and grey should be used.

Repeated terrazzo pattern in lobby of Michigan Avenue Buildin Chicago. Rebori, Wentworth, Dewey and McCormick, architect terrazzo by Novak Mosaic Co.





The colorful esplanade in front of Chicago's Adler Planetarium was constructed in 1933 as an exhibit of the Century of Progress, by the National Terrazzo and Mosaic Association. The floor of the long reflecting basin is terrazzo of many colors.

The terrazzo mixture is spread evenly and rolled thoroughly until compacted. Additional aggregates, to match sample, are spread on the surface during the rolling process so that the finished floor shows approximately 85 per cent exposed aggregate. After rolling, the surface is hand trowelled to an even finish, revealing the metal dividing strips.

After the trowelling is completed, the floor should be wet and kept so until the terrazzo is hard enough to permit machine grinding without dislodging the aggregate. Coarse carborundum grits are used for the initial grinding, after which a light grout of grey or white portland cement is applied to fill small air holes and pits. This grout should be allowed to remain for not less than three days before final grinding or stoning with fine carborundum grits. The floor should be kept thoroughly wet for at least seven days to thoroughly cure. Sisalkraft or wet burlap spread over the floor will assure even curing.

Before subjected to traffic, the surface of a terrazzo floor should be covered with heavy soap suds; the soap, free of caustics, should be allowed to stand over night. The floor should be scrubbed vigorously the next morning and rinsed with hot water. This completes the building of a terrazzo floor and if the work has been done properly the result is a pleasing, colorful finish, sanitary and easy to keep clean.

Just a word may not be amiss about recent developments that presage an even more brilliant future for terrazzo than its colorful past. For the most part, marble has served as terrazzo aggregate, domestic and imported marbles being used. By combinations of the various kinds, a wide range of colors can be obtained. For the more brilliant hues of higher color value than occur in natural materials, manufactured aggregates offer interesting possibilities. Glasses and ceramic materials, available for aggregate in colored concrete, open an interesting field to architects for exploration in an intriguing realm of color for terrazzo floors not heretofore possible even with the most colorful marbles.

File 10-7-1 Being Letters, Notes and Advices About ARCHITECTURAL CONCRETE

THERE are not quite "hundreds," but it seems that many when we try to find space for renderings of the new concrete jobs going up all around. So, the best we can do—even with the two pages we wept for—is to show just a few from here and there. Where we can't show pictures, however, we will tell a little about what's happening.

• •

O & T are Busy

The firm of N. W. Overstreet and Town, Jackson, Miss., architects, are busy overseeing three new concrete projects of their design. The Jackson School, awarded to W. J. McGee, local contractor, at a bid price of $245,894, is under construction. Another job, a school at Benoit, Miss., started construction April 1, with M. T. Reed Construction Co., of Belzoni, Miss., as contractor. The third project, an addition to the Holmes County Jail and modernizing of the older structure to conform

Alabama Highway Department Building under construction at Montgomery. H. H. Houk, state highway engineer; Warren, Knight & Davis, Birmingham, consulting architects.

One of several proposed Nebraska armories is now being built of monolithic concrete at Kearney. E. F. Adams of Lincoln is the designer. Work is being done by WPA labor.

In memory of the late Will Rogers, Balaban & Katz are adding this splendid new concrete theater to their chain of Chicago cinema houses. C. W. and George L. Rapp, architects; Paschen Bros., Inc., contractor.

Quisle & Andrews are contractors for Elmwood Tubercular Sanatorium now being erected at Fort Worth, Tex. Preston M. Green is the architect.

Proposed stadium and field house for Westfield, N. J., public schools. Designed by Coffin & Coffin, New York City; George T. Kelley, Yonkers, is contractor.

to the new concrete section, is now under construction by Currie and Corley, Raleigh, Miss., contractors.

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More Concrete Jails

In Greenville, Ga., the Meriweather County Stockade, designed by Daniell & Boutell, Atlanta architects, is under construction by WPA workers. Alfred Cato, Manchester, Ga., is superintendent on the job.

• •

M. Leo Elliott, Tampa, Fla., is architect of two architectural concrete buildings for the State Penitentiary at Raiford. A hospital and a woman's ward building are now under construction by George Auchter Construction Co., of Jacksonville.

• •

Frank O. Barber, County Architect of Knox County, Tenn., has about completed plans for a new monolithic concrete prison home for inmates at Knox County Prison Farm.

• •

Eureka — an Auditorium

A Civic Auditorium, 165x104 ft. in plan and seating 2,000, is now being built for Eureka, Calif. Except for balcony and roof framing, the auditorium will be reinforced concrete, much of it exposed inside. The splendid design was made by Franklin T. Georgeson. Barret & Hilp, San Francisco, are the contractors.

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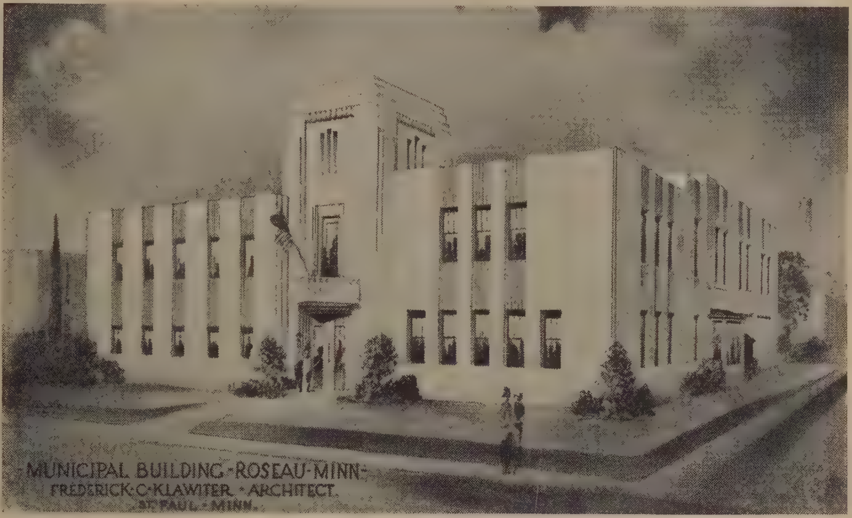
For National Guardsmen

Among the number of new reinforced concrete armory buildings not pictured here is that of the 31st Division, U. S. National Guard, at Mobile, Ala. Now under construction by WPA workers at a cost of $150,000, the structure was designed by Fred W. Clarke of Mobile.

• •

Indianapolis is the site of another large armory, this time for the U. S. Naval Reserve, Indiana area. Designed by Ben H. Bacon and John F. Parrish, Indianapolis architects, the armory is being built with the aid of WPA labor.


MUNICIPAL BUILDING · ROSEAU · MINN ·
FREDERICK · C · KLAWITER · ARCHITECT ·
ST · PAUL · MINN ·

This modern Municipal Building now being erected for Roseau, Minn., was designed in concrete by Frederick C. Klawiter of St. Paul.

New home of Company E, 151st Infantry, now under construction at Darlington, Ind. Designed by John F. Parrish, state architect for national guard armories.

Perspective of new concrete armory under construction at Rock Island, Ill. Benj. A. Horn, architect, of Rock Island. Coath & Goss, contractors, Chicago.

Architectural CONCRETE

ARCHITECT · ENGINEER · CONTRACTOR

IN THIS ISSUE

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33 West Grand Avenue

Chicago

Color Comes To Concrete

WHEN the American Concrete Institute convened in Chicago three months ago, old concrete men blinked their eyes and looked again. What they beheld they had been wanting to see for a long time—the first results of the long quest for true, fast, economical colored aggregate concrete.

A sensation of the Chicago convention was the colored concrete exhibit: large and small panels brilliantly tinted, textured and patterned in hues that would make the rainbows jealous. These sample panels included the work of well known artists executed in sgraffito, in exposed colored glass aggregate and in ceramic aggregate. The fact that these things were exhibited meant that it was now practical to design concrete decoration or even entire buildings in gay, brilliant, thoroughly durable color or delicate, non-fading pastel shades.

For some time, investigators devoted to the search for economical colored concrete have been confident of success. But they promised nothing until they had put their work to thorough tests and found out how and where colored aggregates could be manufactured at costs consistent with economical concrete construction.

It will require some time to tell the story of colored concrete, and ample space in future issues of Architectural Concrete will be devoted to this unfolding. Meanwhile, architects, designers and other artists will have a chance to see the new colored concrete; for the Chicago sample show, 3 tons of it, will depart shortly by truck for a tour of six American cities. The show will include samples of the aggregate, colored concrete panels, design panels, and wall sections showing the application of color in concrete to building construction.

Starting at New York City, the color show will make the following circuit:

New York, May 26 and 27
Philadelphia, June 2, 3 and 4
Washington, D. C., June 8, 9, 10
Atlanta, June 16 and 17
Houston, June 25 and 26
Kansas City, July 1, 2, 3

ORNAMENT

ORNAMENT, broadly speaking, includes an almost endless variety of elements of decoration based upon foliage, animal and human figures, and geometrical shapes. These elements are used alone or combined in various ways, and their application to a building or object of any kind is made in accordance with more or less accepted rules or principles of decoration.

No effort will be made here to discuss what is good or bad in ornament purely as ornament; nor have the examples used as illustrations been selected because they are recommended as most appropriate for architectural concrete ornament. It is intended simply to call attention to some of the ways of producing ornament in concrete which may be helpful to the architect in developing designs most readily and economically executed and to point out some construction "kinks" which may aid the contractor on the job.

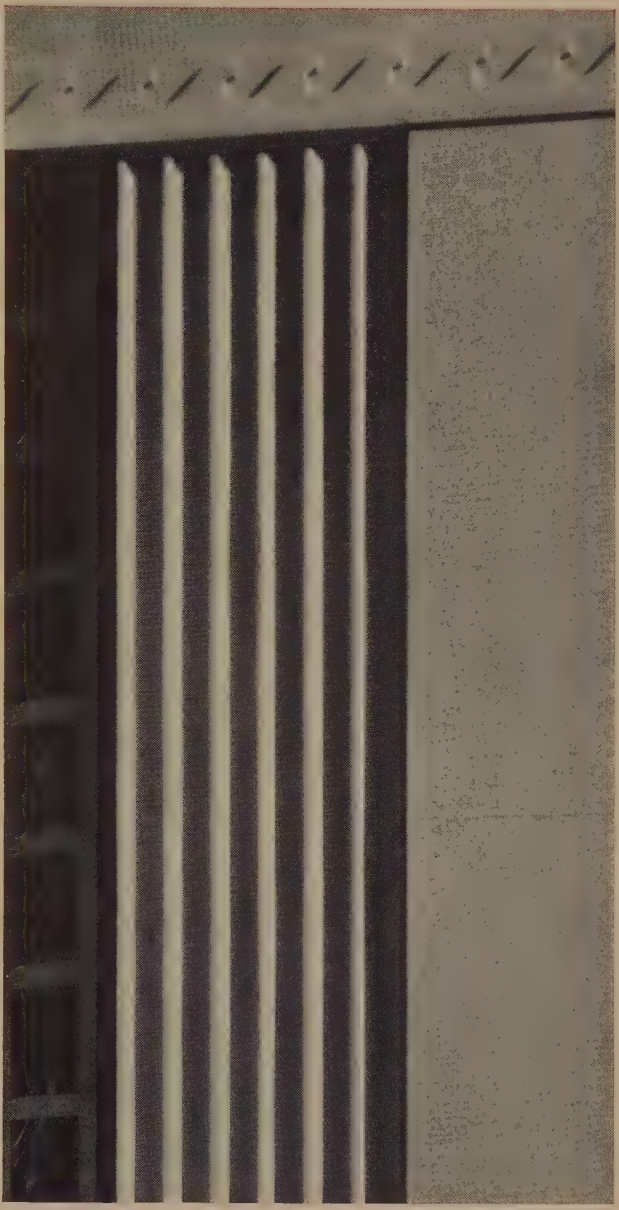
It is probably true that a designer has more latitude in the choice of ornament to be executed in concrete than in any other material. This may be a temptation to over-ornamentation or to use designs which may complicate the construction.

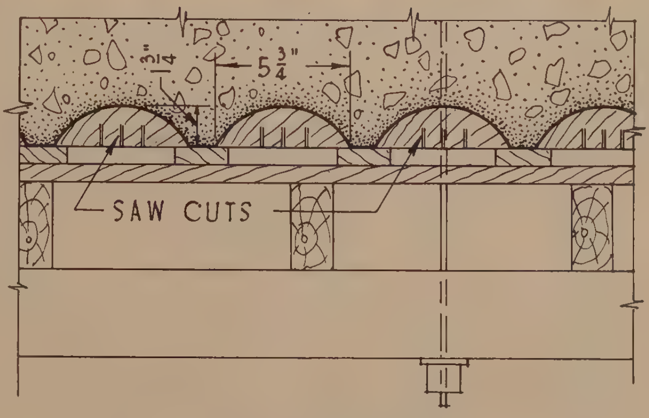
Foliated ornament, animal and human forms and in fact practically any type involving curved outlines, warped surfaces and undercuts must be cast in plaster waste molds. With such forms there is virtually no limitation on the intricacy of design other than the ornamental plasterer's ability to make the mold. Very fine detail, extremely thin members and deep undercuts should generally be avoided because of the possibility of breakage, excessive cost and the fact that such ornament is not fundamentally in keeping with the nature of the material. Bold, strong detail with full rounded forms without intricate, minute shapes is conducive to perfection in the execution of the design and to least cost.

Geometrical patterns, particularly those consisting of straight lines, can usually be formed with wood. If the design is to be repeated many times, as in band motifs, it may be desirable to use plaster molds for geometrical as well as natural ornament, where many members are involved.

A common type of ornament presenting almost infinite variations is fluting. Examples are shown in Figs. 1, 6 and 7. The beauty of fluting lies in perfection of alignment and sharpness of the detail. Broken arrises cannot be tolerated. If the flutes are rather deep in proportion to the width, as in Fig. 1, several kerfs in the backs of the strips forming the flutes will prevent damaged corners. Rectangular flutes should always be detailed with a little draw, as illustrated in Fig. 6, or the form will wedge so tightly that corners are almost certain to be broken when stripping. If triangular shapes are used either alone, as in Fig. 7, or in combination with flutes of other shapes, the forms should always be made in pieces to join along the arrises. If a single strip were used to form the detail in Fig. 7, it would split at the thin section leaving an irregular, rough edge.

Geometrical ornaments are generally divided into three groups; bands, panels and unlimited flat patterns. As far as their design or construction in architectural concrete is con-





CROSS SECTION
FIG. I

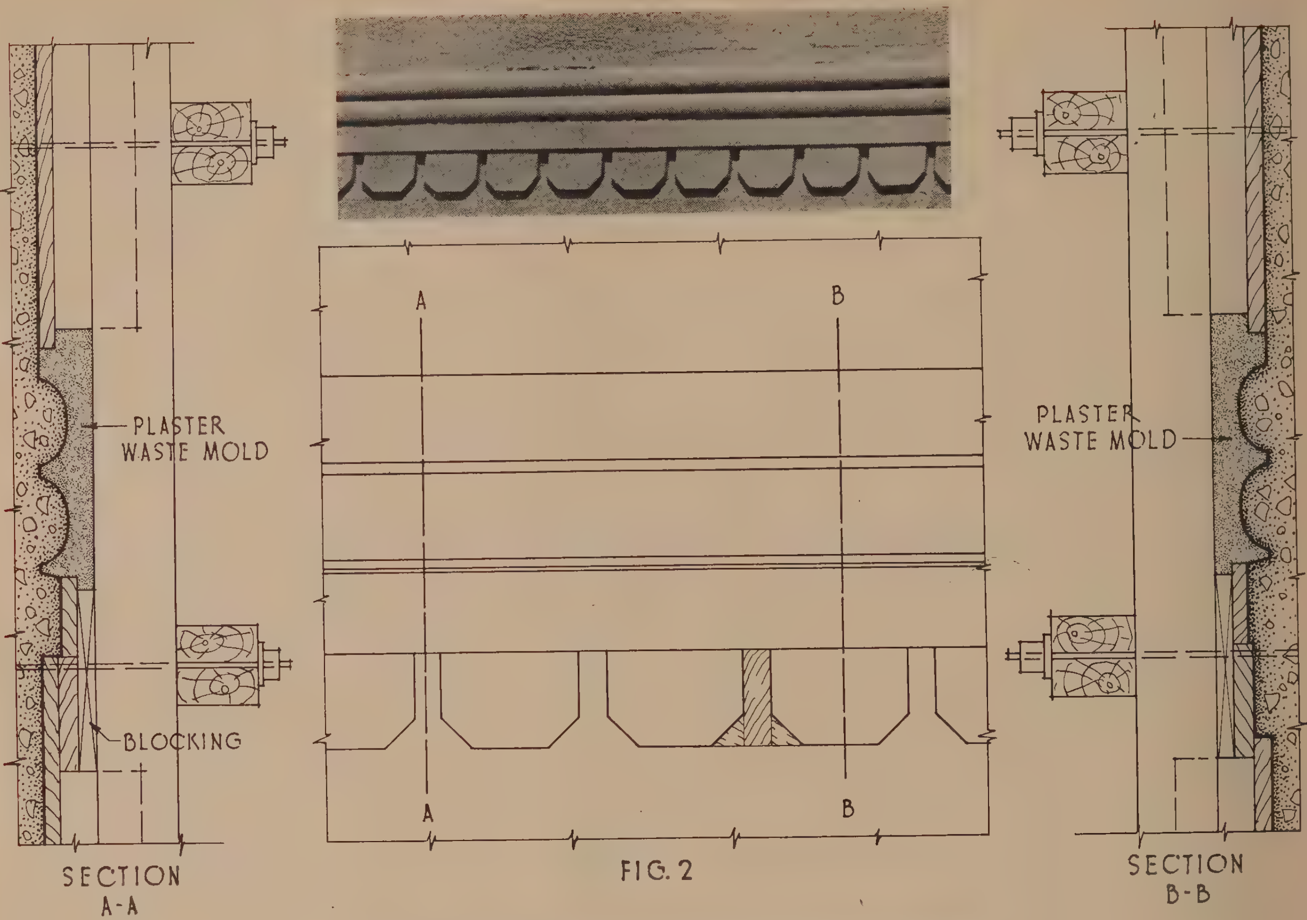

PLASTER WASTE MOLD
BLOCKING
SECTION A-A
A
B
A
B
PLASTER WASTE MOLD
SECTION B-B

FIG. 2

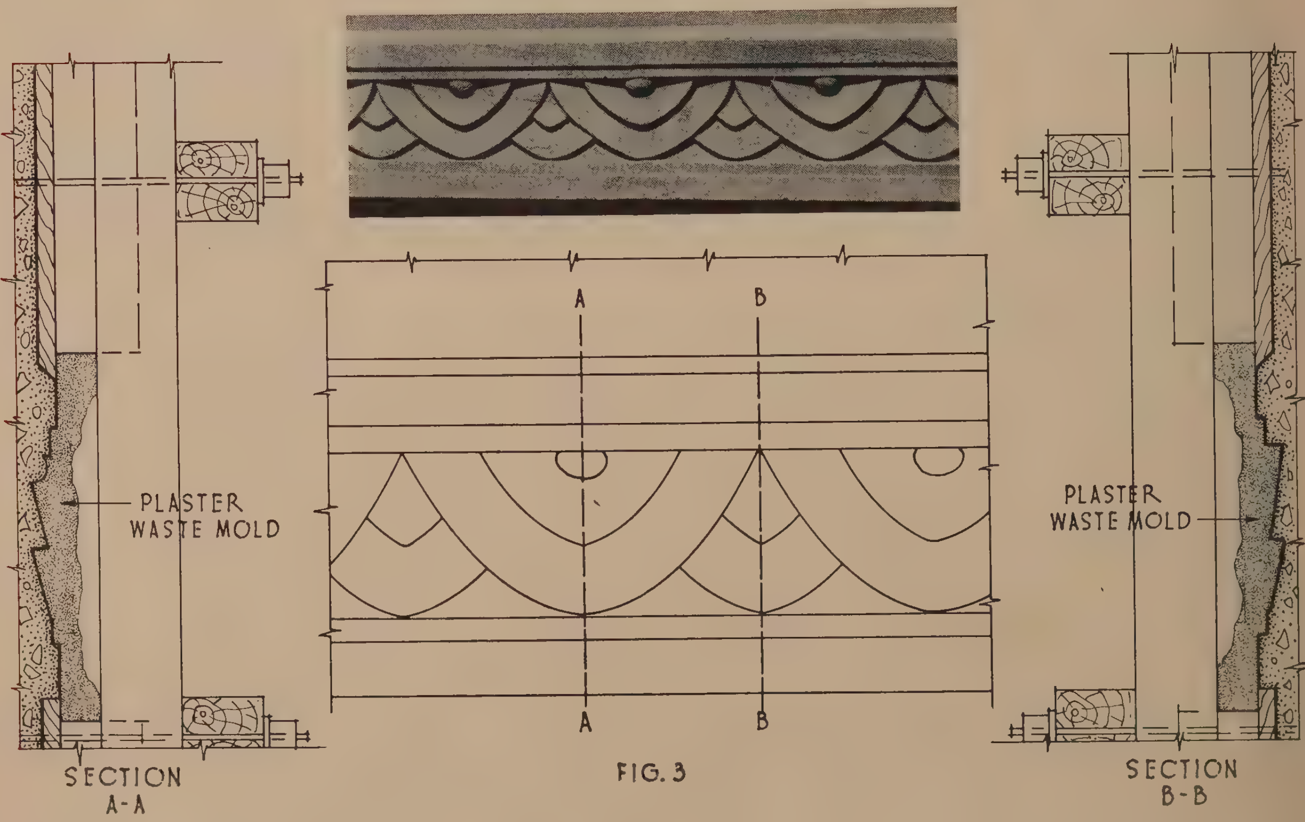

PLASTER WASTE MOLD
SECTION A-A
A
B
A
B
PLASTER WASTE MOLD
SECTION B-B

FIG. 3

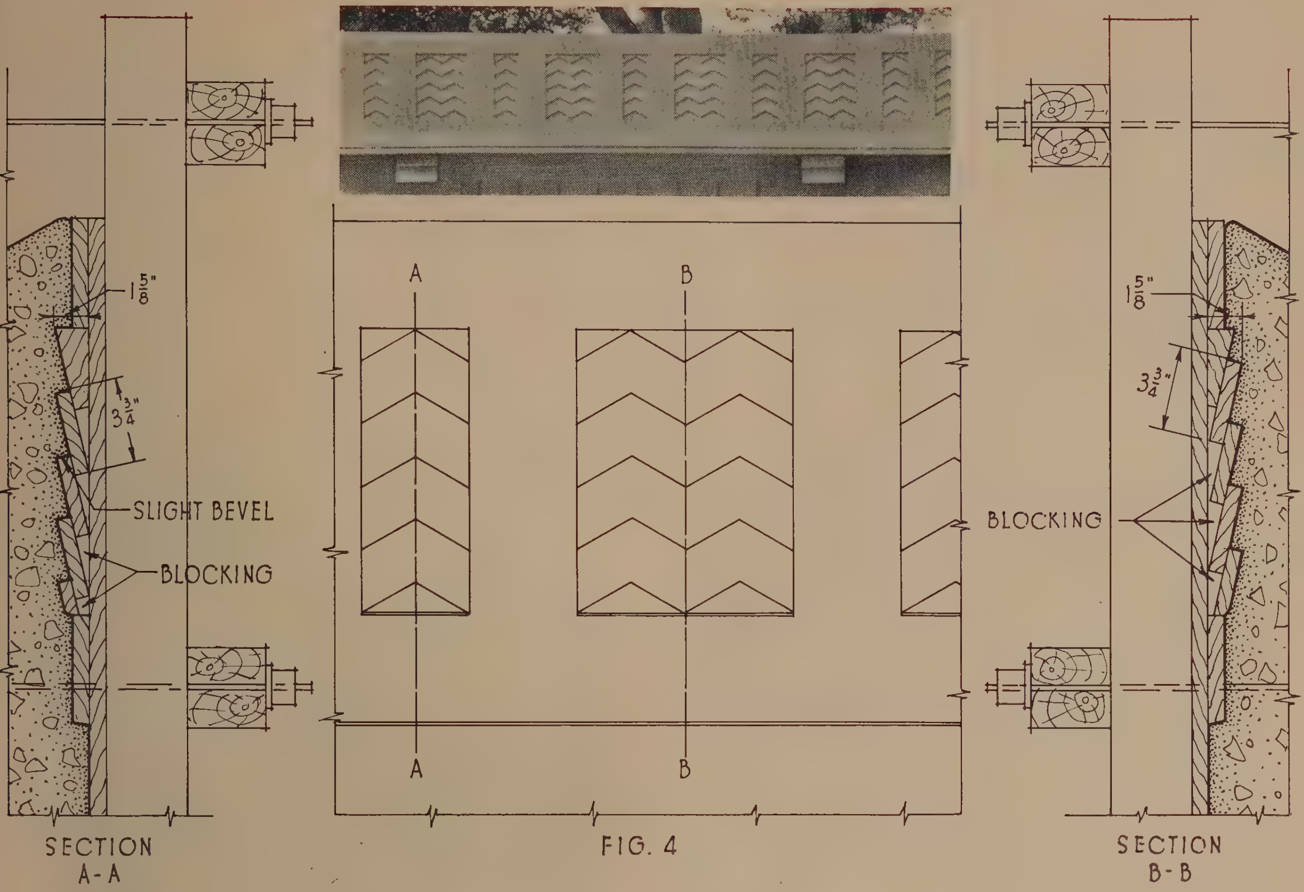

A
B
A
B
$1\frac{5}{8}$"
$3\frac{3}{4}$"
SLIGHT BEVEL
BLOCKING
SECTION A-A
$1\frac{5}{8}$"
$3\frac{3}{4}$"
BLOCKING
SECTION B-B

FIG. 4

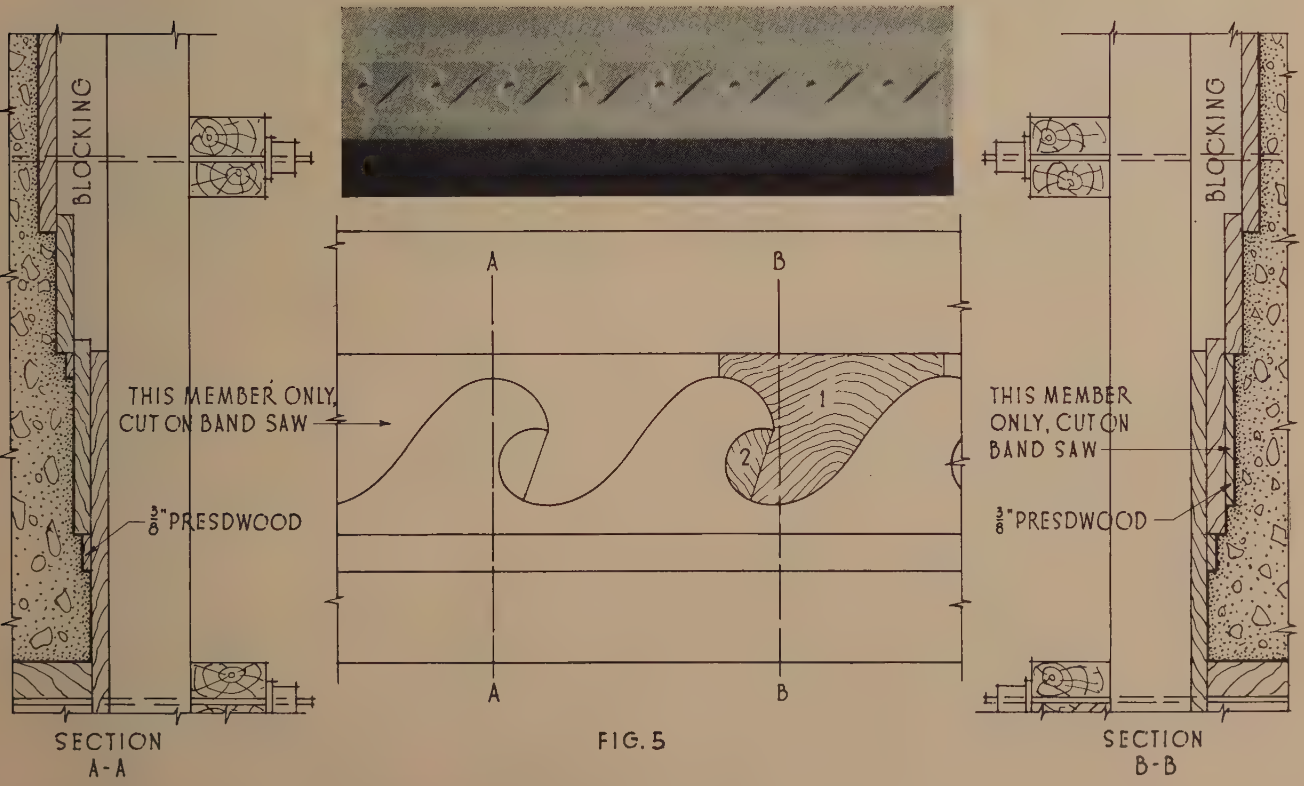
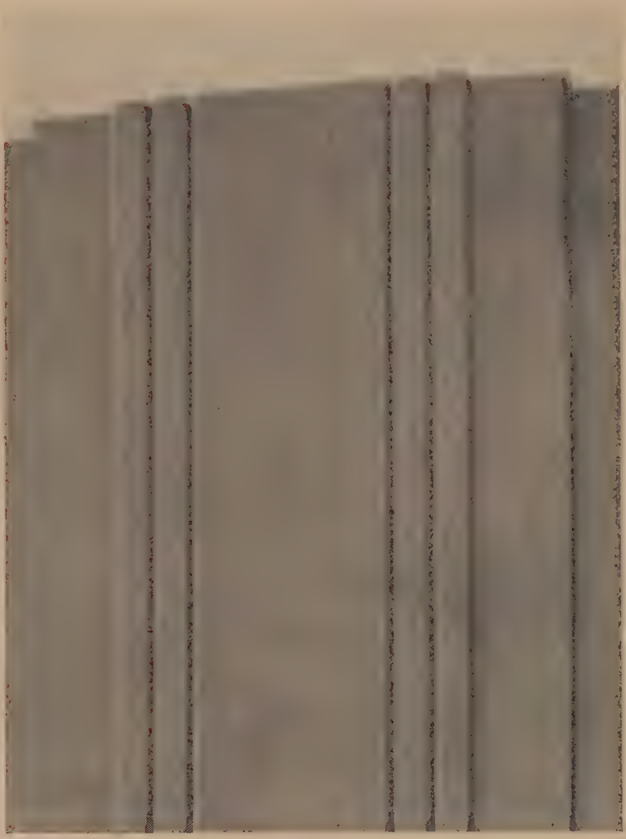

BLOCKING
$\frac{3}{8}$" PRESDWOOD
SECTION A-A
A
B
A
B
THIS MEMBER ONLY, CUT ON BAND SAW
1
2
THIS MEMBER ONLY, CUT ON BAND SAW
BLOCKING
$\frac{3}{8}$" PRESDWOOD
SECTION B-B

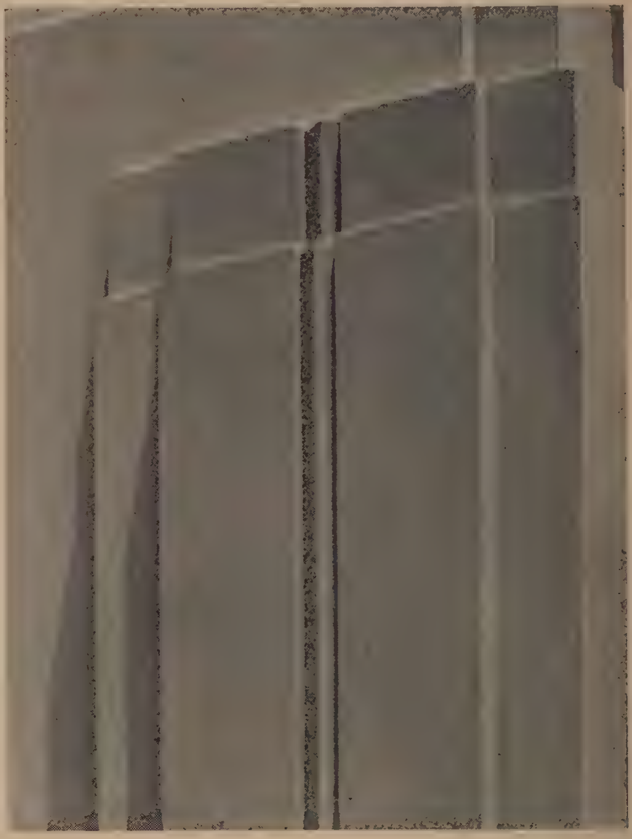
FIG. 5

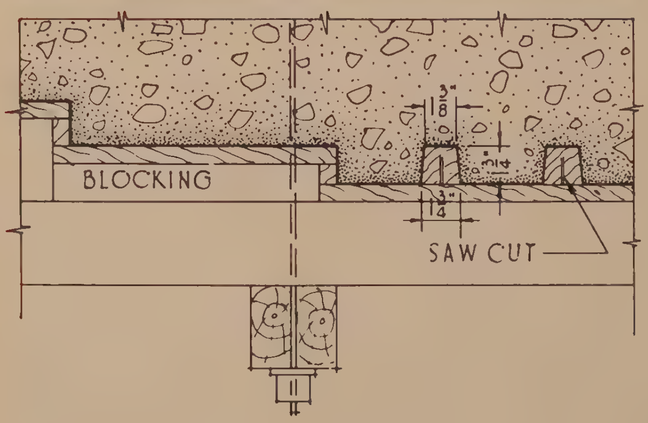
cerned, there is little difference between these groups, except that waste molds will be used more frequently for the bands and repeated patterns. Even some band motifs when quite simple are economically formed with wood molds. The dentil-like projections in the band in Fig. 2 are easily formed with three pieces of wood that can be made in quantities in the mill. A plaster mold is best used for the continuous rounded moldings above the dentils. The motif in Fig. 3 would be difficult and, in fact, some parts of it impossible to execute in wood forms, but can be constructed easily with plaster molds. The design is very much in keeping with the material.

The detail in Fig. 4 can be made with stock sizes of lumber. No complicated nor difficult shaping is required, yet an interesting ornament is produced. If the ornament is to be repeated many times, waste molds may be more economical than wood forms.

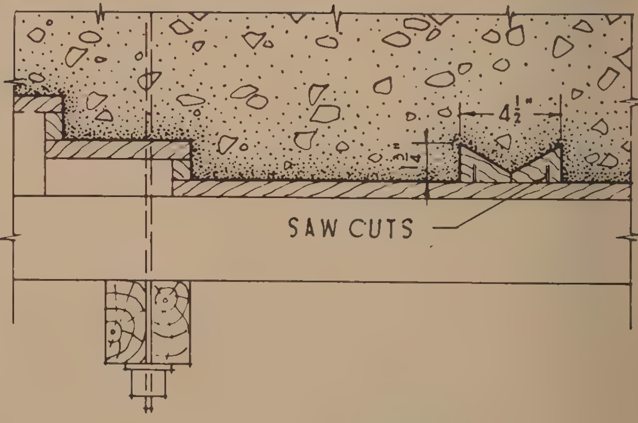
Ornament involving a scroll design such as shown in Fig. 5 can be formed without plaster molds if the reveal of the scroll is not more than ⅜ in. The scroll form is best made from Presdwood cut to shape on a band saw. Two pieces, marked *1* and *2*, should be used rather than a single piece, because when any shape is more than a half circle, the form will swell and bind so that sharp corners are likely to be broken in stripping. All other pieces required for this band motif are straight standard thickness boards.







CROSS SECTION
FIG. 6



CROSS SECTION
FIG. 7

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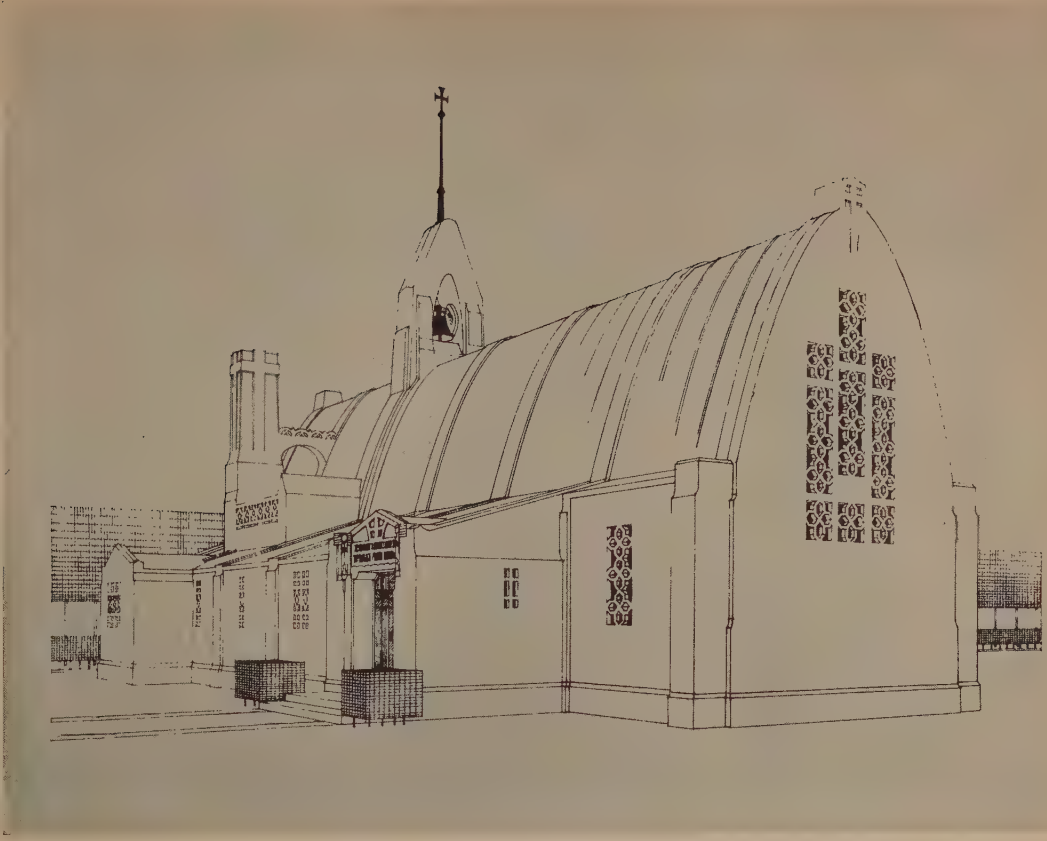

Believing that the parabola is a logical development of the Gothic arch, Architect William Heyl Thompson has designed a modern church using this simple, rhythmic form to preserve the ecclesiastical tradition. In concrete, the parabolic arch performs both structural and decorative functions.

Concrete for Ecclesiastical Architecture

A Study in Design—By William Heyl Thompson, A.I.A.*

THERE is little doubt that the architectural profession is faced today—as it always has been—with the problem of building economically as well as soundly. The ideal is to combine materials that will produce this result with the greatest beauty and with assurance that the materials will withstand the toll of time and the elements.

This ideal is not new. It was particularly true in the architectural expression of the Middle Ages when building was chiefly ecclesiastical. And it seems once more that we are starting out with this fundamental idea, no doubt forced by the complete re-adjustment of our whole economic scheme and the necessity to erect buildings at the least possible cost.

During the Middle Ages, Christianity reached its greatest influence and produced its greatest architecture. At that time the church was the center of culture and, indeed, of life itself. It was the one eternal verity. It was sacred, enduring, everlasting; and it was a symbol of belief both ecclesiastically and architecturally. So it is only natural that builders of churches today should turn to that period for inspiration and to discover what was the philosophy of the builders of that time.

Their main problem, of course, was the roof—just as it is today and probably ever will be. And it was this task that finally produced great Gothic architecture. A concentration of what we are pleased to call "genius" made this possible. That genius was faced with the Roman tradition of unlimited labor which permitted the erection of great masses of masonry without regard to economy. Naturally, with these means at their command, the Romans were able to achieve resistance to the thrusts of their structures that the medieval builders could not approach. It was necessary, therefore, for medieval designers to invent new methods of

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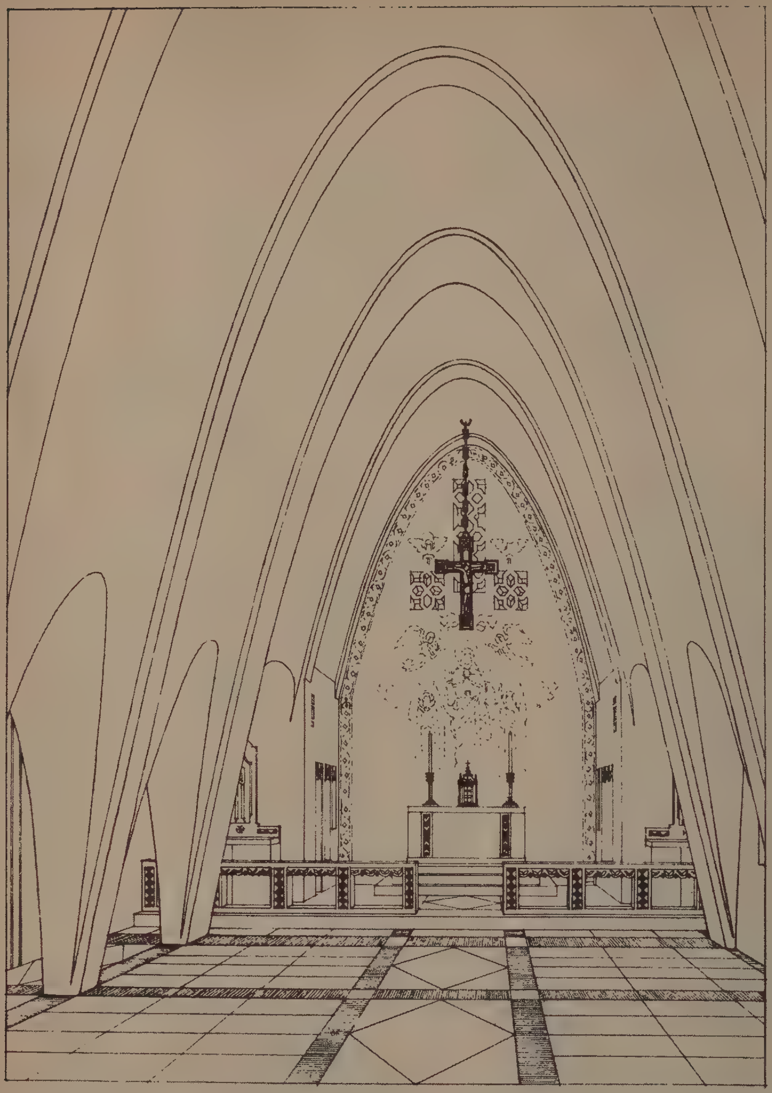
*Of the firm of Frank R. Watson, Edkins and Thompson, Philadelphia.



Where it spans the nave, the parabolic arch seems to spring upward in a never ending curve, the side arches leading a rhythmic procession to the altar.

conquering these thrusts with far less material and labor.

The solution of this problem developed from the old Roman barrel and groined vaults. In the construction of the groined vault, medieval builders raised the crowns of the semi-circles to better withstand the horizontal thrusts and here the pointed arch is believed to have made its appearance. The groins were next developed as ribs, and the thrusts from these ribs were thrown upon isolated supports which were counter-balanced by other thrusts.

Had the period continued to flower, it does not seem unlikely that the desire to reduce these thrusts might have developed into use of the parabolic form of arch, and even into the use of concrete. It is only another step in the progress of construction. The parabola is based upon pure geometry, and is a form that is not only logical but beautiful as well. Near its base it is almost vertical, but ever curving, and the thrust carries an evenly distributed load. In its form and its thrust it does not seem incongruous with the spirit of Gothic architecture.

Just as Greek and medieval buildings were first developed from solid engineering principles which were then refined into esthetic forms, so we now find the parabolic arch and plastic concrete, in their pure structural forms, also becoming beautiful. Thus, it was with no small amount of interest and enthusiasm that we welcomed the suggestion of John J. Earley* that we develop a design for a church to be built of this material, based upon this structural form.

Here was a plastic material and a form entirely consistent with the Gothic tradition both from economical and structural viewpoints. As already successfully used in some modern churches in Germany, Holland and Sweden, it seemed to respond to every reasonable desire of the designer both structurally and esthetically. Where it spans a nave it seems to spring upward in a never ending curve; or where it becomes the arches of a nave it forms a rhythmic procession leading forward to the altar. To the sculptor it presents a medium of great mobility, and to the molder of concrete it assumes simple, rhythmic forms. As to surface treatment, whether it be with pigments or exposed aggregates, the possibilities are unlimited.

The little church reproduced here is but a modest attempt at expression based on a form and a material containing limitless possibilities. It makes no boast of reaching the ultimate ideals set forth for these materials. It is one of two designs which were developed with the idea that they might present starting points in a development toward greater and more beautiful structures based on the parabolic form.

In the arrangement of its interior, it consists of the usual liturgical plan where the side aisle is divided from the nave by a procession of arches while over the nave six bays of the same type of arch swing upward.

Interior surfaces were considered as spaces for treatment by application of pigments or exposed aggregates. Great possibilities present themselves here for color in simple design patterns accentuating certain treatments, or in lovely murals rising on the walls behind the high altar and the side altars. Windows of the aisles and at the east and west ends are simple, geometric shapes piercing the con-

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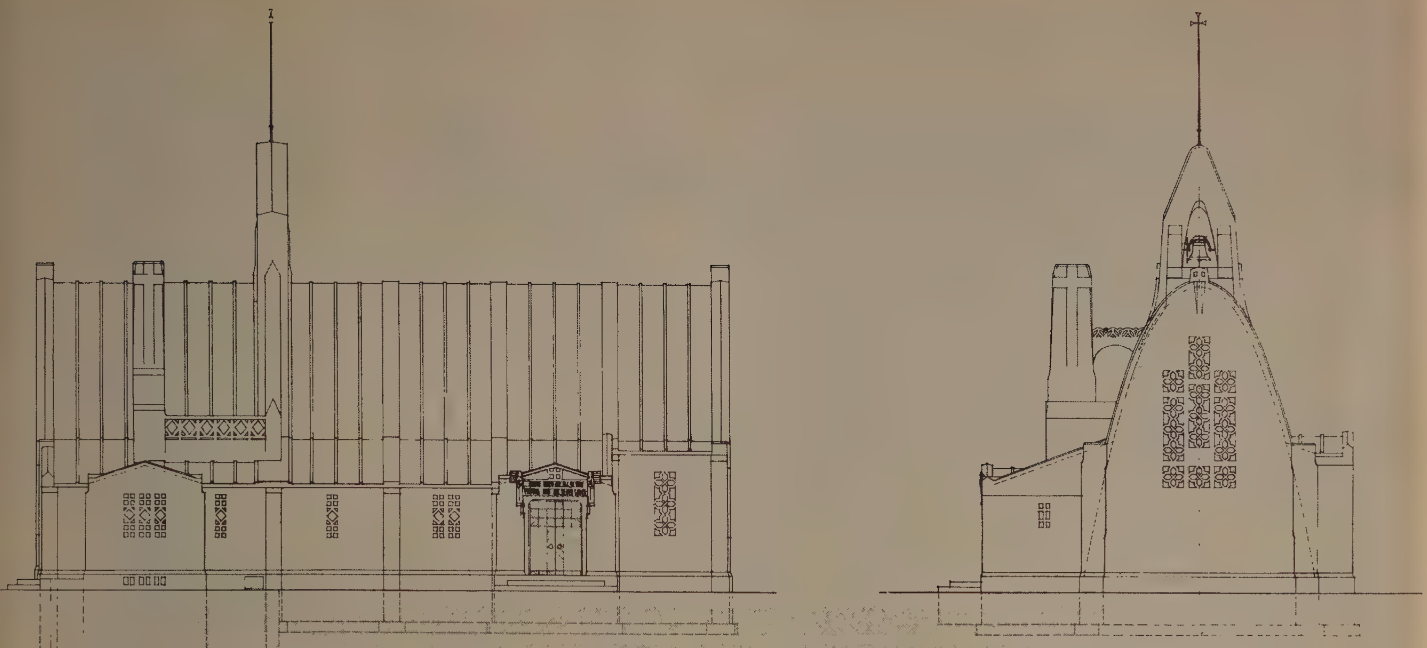
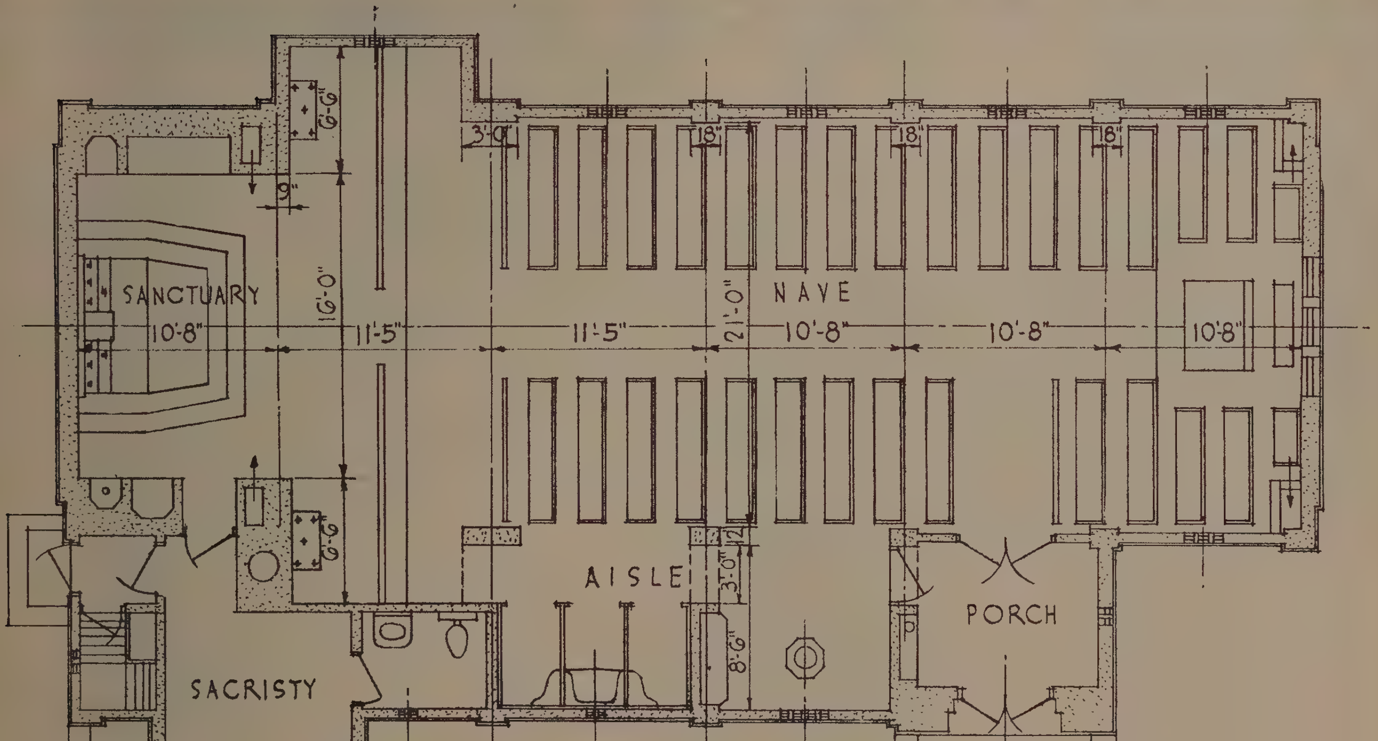
*Architectural Sculptor, Washington, D. C.





FIRST FLOOR PLAN

PLAN OF THE CHURCH—William Heyl Thompson, Architect.

crete. The voids equal approximately the geometric divisions of the design, and would be filled with jewels of colored glass. The concrete pattern surrounding these voids would be treated in strong reflective colors which at night could be brilliantly lighted from reflectors concealed in the window jambs. Thus, these windows would be real sources of light by day or by night.

The altars themselves, as well as other parts of the work described, would be carried out in concrete and exposed colored aggregates similar in treatment to that in the Shrine of the Sacred Heart in Washington, D. C. The floors of the sanctuary, baptistry, porch and aisles would be terrazzo in simple or elaborate designs as their importance dictates. The only wood in the whole structure would be the pews and the confessionals, as even the sanctuary rail could be constructed of pierced concrete in many colors.

The entire exterior surface of the church would be of concrete, relieved here and there with pierced concrete ornament. This exterior could be treated in several ways in one or more colors. The roof could be of one color and texture and the walls of another.

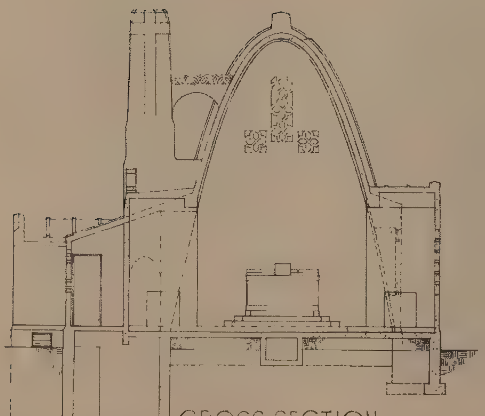
Sculpture indicated at the main entrance would be molded plastically and, with surrounding ornament in color, form a fitting frame for doors of beaten or etched copper. Above all there rises a small belfry surmounted by a cross which could blaze forth in many beautiful colors.

It is unfortunate that at the time the design was developed it was thought more economical to cover the sacristy, baptistry and porch with slab and beam construction. The model that Mr. Earley developed of the church showed that possibly this might be out of key with that elastic rhythmic quality expressed by the other parts of the structure, and a parabolic arch would be more in harmony.

One of the advantages of reinforced concrete is that it is possible to construct, with proper reinforcing, a very thin barrel shell in which there is practically no bending stress. A minimum amount of material is required and, furthermore, the construction methods involved are not costly nor complicated.

A sectional form would be built on the site for one bay, which in turn could be used for each succeeding bay after each bay had been cast. This would form a standard by which more than one building of this kind could be erected, thereby lowering costs. As for the exterior and interior surface treatments: they could all be different and give to each church erected its own distinctive and individual charm.

Structures developed along these lines could do much to improve our ecclesiastical architecture which is now dotting the countryside with such ill-fitting grace and total lack of inspiration.



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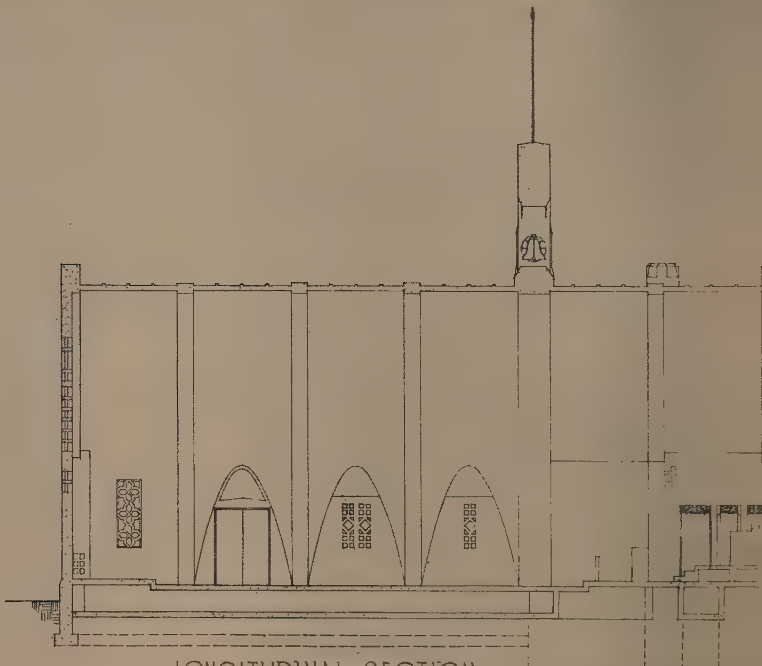

LONGITUDINAL SECTION

Wind Tunnel at Chalais-Meudon

By G. Le Marec*

Editor's Note: Constant efforts to perfect the airplane as a safe mode of transportation have raised the science of aerodynamics to new importance. It has taken this study out of its obscure corner of the laboratory into huge laboratories of its own. In America and abroad, wind tunnels and air blowers in which full sized airplanes can be studied and observed under variable wind conditions have been designed and built in increasing numbers. The erection of these vast chambers of controlled air drafts has created fascinating problems in design and construction. The following article describing the great Chalais-Meudon wind tunnel, built for the French air service, is an abstract of an article by G. Le Marec in Le Genie Civil and is published here because of its interest to American engineers and designers as an unusual engineering accomplishment. It is our feeling, however, that this inflexibly functional structure has another and an entirely different appeal—a strange, thrilling, impressive beauty. It demonstrates what many modern designers and critics have been emphasizing—that structural elements executed in modern materials have unlimited esthetic possibilities—that form dictated by function shall be a fundamental principle of architecture.

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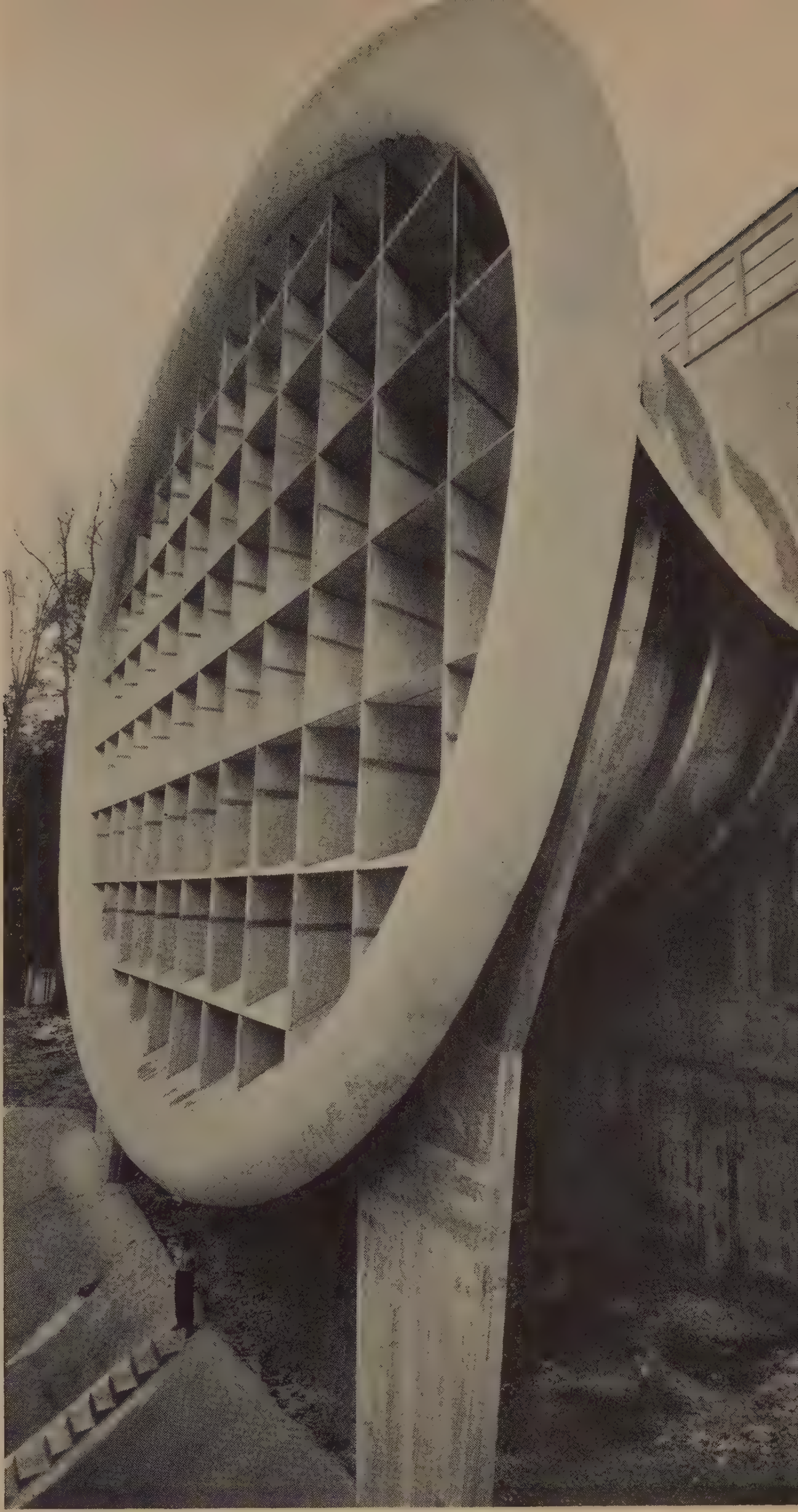
THE difficulty of solving the very complex problems of aerodynamics by theory alone has led plane builders to experimental methods involving small models. With the idea of adding precision to the results obtained and to approach the real phenomena of air flow, the French Aeronautical Technical Service decided to erect at the air base at Chalais-Meudon a large wind tunnel for practical testing of planes and appliances. The program for building this huge wind blower was set in operation by the air ministry and M. Lapresle, chief aeronautical engineer, is credited with the aerodynamic design. The construction program was planned by M. Aimond,



Collector end of the huge Chalais-Meudon wind tunnel, built for the French Air Ministry to test airplanes and equipment. Entirely of concrete even to the slender panels of the filter over the face of the collector, the monstrous size of the building may be judged by the height of the man standing below. Aerodynamic design by M. Lapresle, chief aeronautical engineer, French Air Ministry. Structural design and construction by the Societe Anonyme des Entreprises Limousin, Paris.

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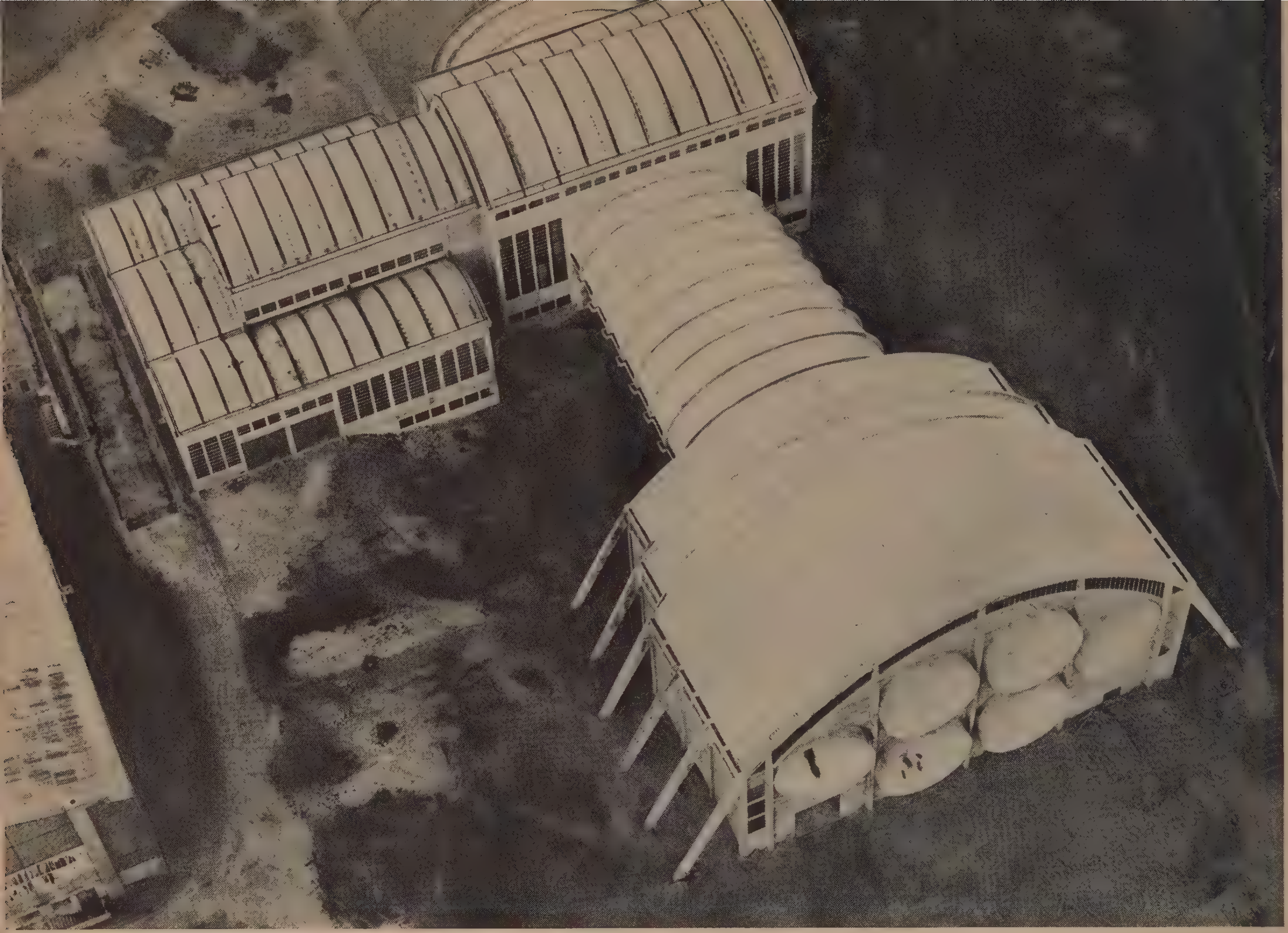
*Technical Director *Societe Anonyme des Entreprises Limousin.*



Aerial view of wind tunnel structure. At the back of photo is collector and testing chamber flanked at left by laboratory building. The central diffuser connects the testing chamber to exhaustion chamber in foreground. Note different angles of propeller housings.

France's well-known engineer of bridges and highways.

An unusual feature of the program was the form of the contract. Instead of preparing a complete design with all construction details worked out in advance of the bidding, the general problem was laid in the laps of the various bidders and each was required to submit a solution conforming to the precisely specified dimensions, forms and arrangement of the structure. The successful bidder, therefore, was the one who not only submitted a low price for the construction, but offered the most satisfactory solution of the problem from a technical standpoint. The Societe Anonyme des Entreprises Limousin was awarded the contract.

A complete examination of the wind tunnel as an aerodynamic machine would require many pages. Let it suffice here to explain that the airplane to be tested is placed between a collector and a diffuser, at the back of which air is exhausted by means of six propellers of about 28-ft. diameter, activated by electric motors of 1000 h.p. Measuring apparatus, located near the airplane, registers various results sought.

Of chief importance to this discussion are five principal parts of the structure:

1. A collector, designed to draw the exterior air in, to filter it, and to set it in the right direction before entering the testing chamber;
2. A testing chamber, in which the airplane is installed for the tests;
3. A central diffuser, made to regulate the flow of air from the testing chamber;
4. An exhaustion chamber, serving as a regulator between the central diffuser and the propellers; and,
5. Six propellers which create the air current by exhaustion of the interior and force the air outside.

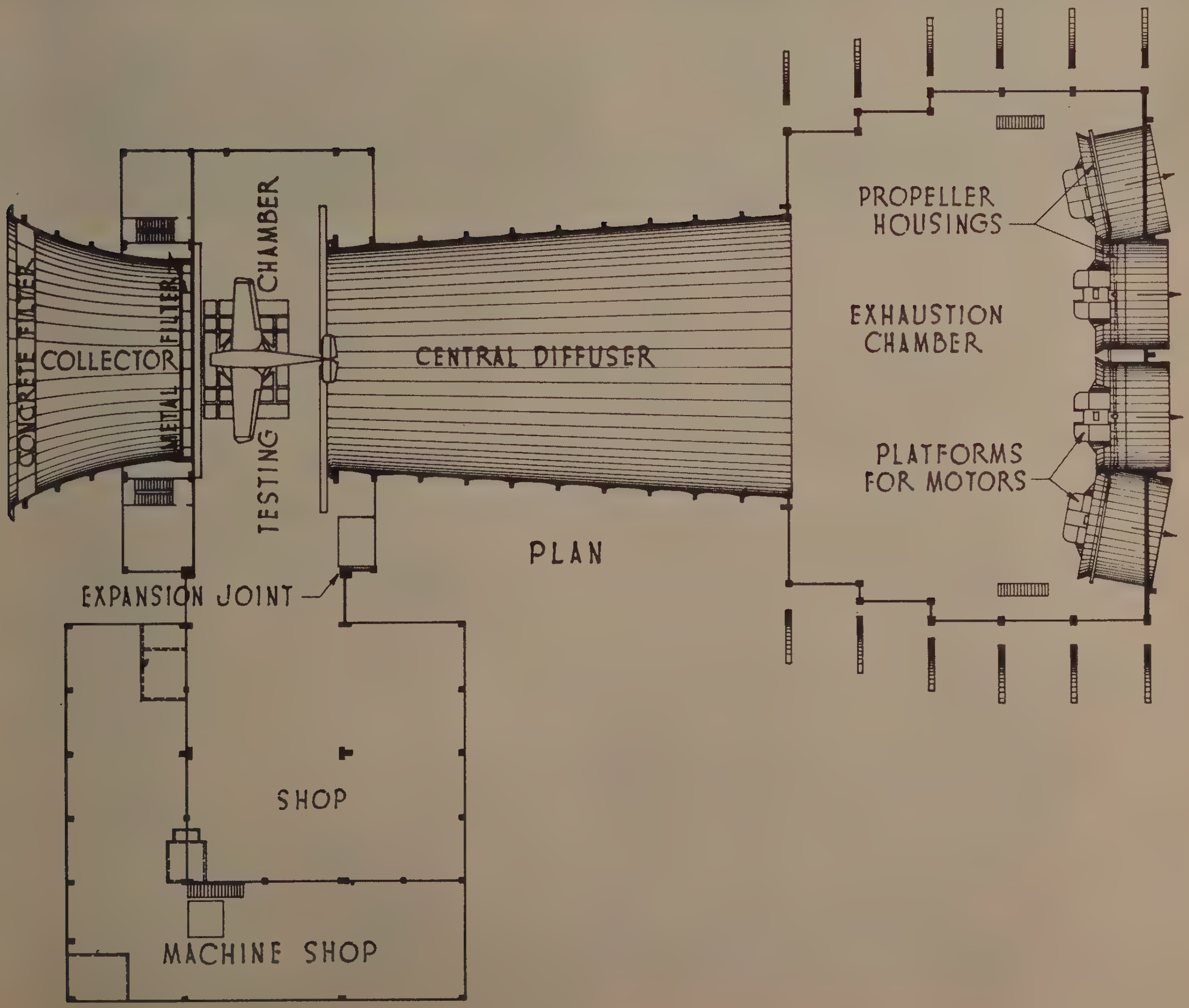
The accompanying drawing shows the plan of this structure in which a draft of air about 312 ft. long moving in a determined direction at speeds up to 113 m.p.h. is created.

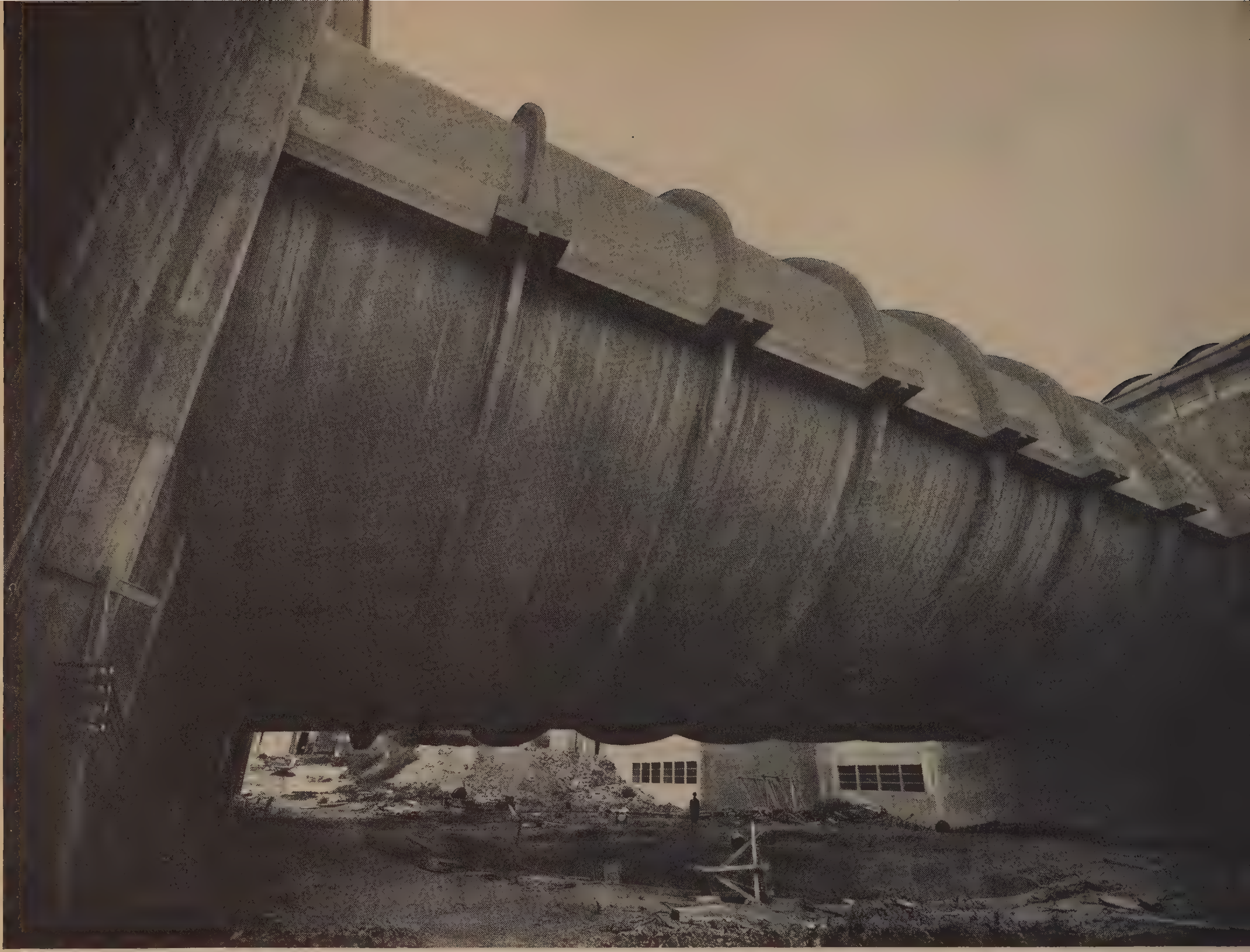
The collector has a total length of 50 ft. Its transverse section is an ellipse of variable dimensions. The horizontal axis is 81 ft. at the entrance and 52 ft. 6 in. at the outlet to the testing chamber. The vertical axis varies from 55 ft. to 26 ft. The collector comprises a shell of reinforced concrete 2¾ in. thick, stiffened by ribs on the outside. It is supported just back of the entrance by a frame or collar completely independent of the rest of the structure and at the exit by the wall of the testing chamber. At each end of the collector are filters consisting of horizontal and vertical converging planes to regulate the direction of the air stream. The outer filter, 5 ft. from the entrance, is made of thin sections of reinforced concrete; the planes, if projected, intersect in lines which cross at the pole of the filter where the airplane is placed. The inner filter is made of metal and can be rotated about its horizontal axis to change the direction of the air current.

The testing chamber is a large room 65x69 ft., situated between the collector and diffuser. It affords an unobstructed space about 45 ft. high. An electric overhead traveling crane places the airplanes in position on a massive support located at floor level. On either side of the testing chamber is a hall, and overhead an observation balcony.

In order to shut out cold air while apparatus is being set up, metal shutters are located over both the collector and diffuser openings into the testing chamber. These shutters are opened only when testing is carried on.

The central diffuser is a long tube of reinforced concrete 124½ ft. long, of which 112 ft. has no support other than the walls of the testing chamber on one end and the exhaustion chamber on the other. The tube is a reinforced concrete shell about 2¾ in. thick stiffened by ribs 6¼x23½ in. running around the extrados at intervals of 12 ft. Like the collector, the diffuser tube has an elliptical section. The horizontal axis varies from 59 to 75 ft. and the vertical axis from 33 to 49 ft. There are no obstructions inside the diffuser tube.





The central diffuser is a long, elliptical thin concrete shell stiffened by ribs running around the shell. Designing this long unsupported member was one of the many delicate problems of the project.

The exhaustion chamber, located at the end of the diffuser, is 95 ft. long and varies in width from 118 ft. at the diffuser opening to 140 ft. at the exterior wall. The height of the arched roof varies from 74 to 85 ft.

The six propeller housings consist of frustrums of cones joined to cylinders 28½ ft. in diameter. The total length of the housings is 19½ ft. and the concrete shell thickness 3½ in. The propeller housings are supported by two walls of reinforced concrete, one of which is the outside wall of the building.

Conditions peculiar to the function of the wind tunnel made the following requirements necessary in the construction:

1. No fixed obstruction could be placed in the main air passage including the collector and diffuser, the central part of the testing chamber and the entire exhaustion chamber.

2. The interior outline of the air passage had to be built with extreme accurateness. Errors tolerated could not exceed .10 in. for the filter, .39 in. for the collector, .78 in. for the diffuser and .10 in. for the propeller housings.

3. A surface which would be as resistant to erosion as possible had to be provided throughout the length of the air passage and attached rooms.

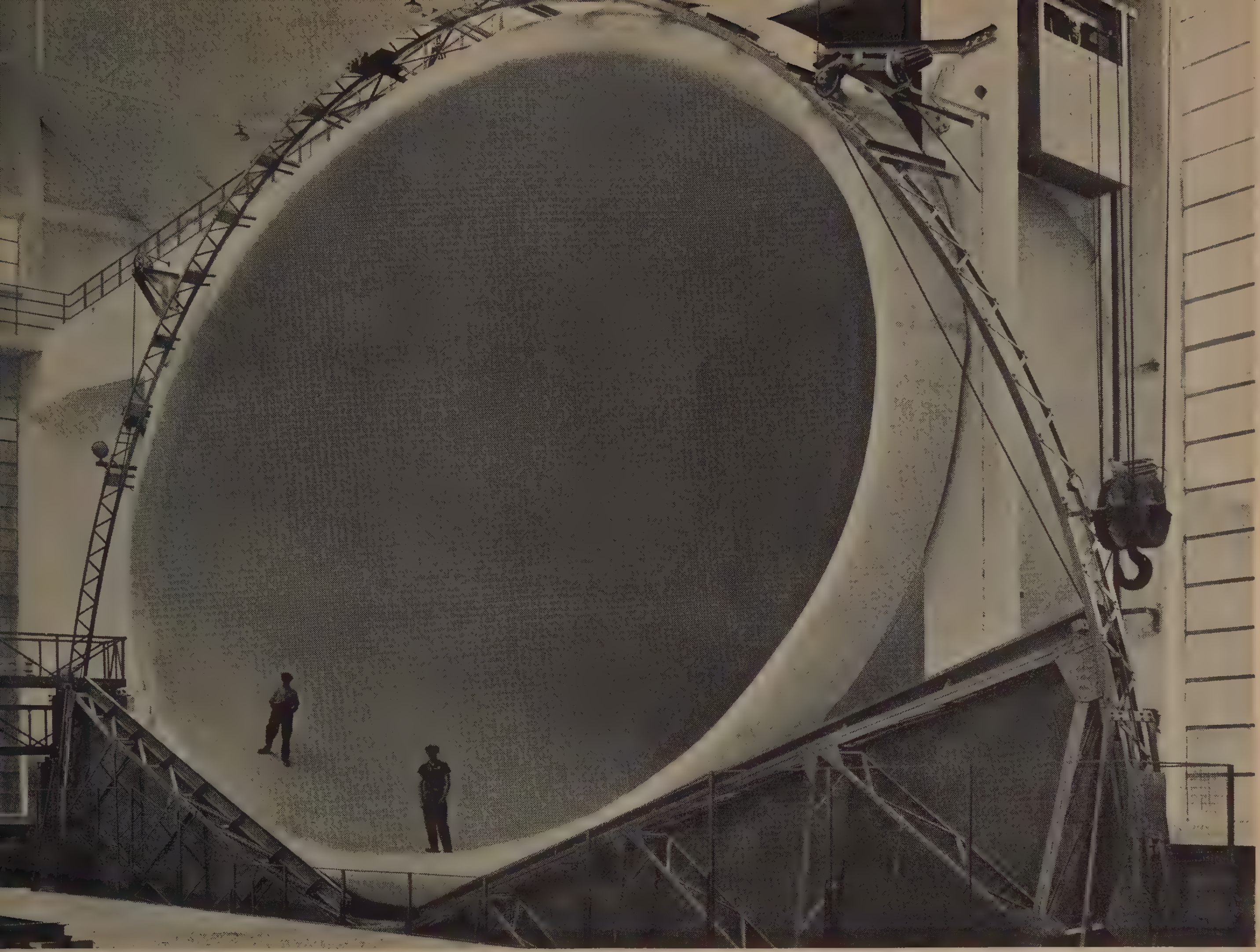
4. In the design of the structure, the following loads due to exhaustion of the air from the interior had to be considered:

Collector: pressure uniformly distributed, varying from zero at the outside to 33 lb. per sq. ft. at the exit of the testing chamber.

Testing chamber and its annexes: uniform pressure of 33 lb. per sq. ft.

Central diffuser: pressure varying from 33 to 17 lb. per sq. ft.

Exhaustion chamber: uniform pressure of 19 lb. per sq. ft.



Central diffuser door from testing chamber. To avoid cold within the chamber, doors were built over the openings of both the collector and diffuser. Here the door is designed as a huge fan, sliding up into position from slots in the foundations. Note the smooth finish of the diffuser walls, necessary to permit free, unobstructed passage of air.

These rigid and numerous conditions led the builders to seek maximum simplicity of forms which, alone, could assure exactness of execution in the structure which must also be as homogeneous and monolithic as possible. This objective was obtained by the use of reinforced concrete, not only for the principal parts of the structure, but also for the interior partitions which were cast in place, contributing to the general stability of the building.

While the design and construction of the collector and diffuser were much alike, the latter, because of its great unsupported length, deserves special mention. The problem was to build accurately and economically a hollow tube with a variable elliptical section and of exceptional dimensions.

The design was not solely a matter of calculation, but "construction sense" was necessary to devise a simple solution, easy to execute and economical. When the cross section of the enormous elliptic cone was considered, the extraordinary moment of inertia of this ring was apparent. It was felt that the tube could carry itself, as a long span girder, and there was no need to use intermediate supports. This necessitated reducing the shell and rib thicknesses to a minimum, since even a small decrease in weight made a very great difference in the bending moments.

The total weight of the diffuser was approximately 1,280,000 lb. and the snow load was assumed to be 15 p.s.f. An external wind load in accordance with standard practice was considered in the design as well as a maximum air pressure of 33 p.s.f. due to the suction inside the structure.

On account of the thinness of the elliptical shell, being only 2¾ in. thick, it has little resistance to bending. However, where the tangents to the cross section are vertical, the shell acts much as a diaphragm to carry vertical loads, and the ribs spaced at 12-ft. intervals prevent buckling.

The method of analyzing the stresses in the diffuser was very similar to that used in the design of long span hangar roofs supported at four points without tension ties.* In effect, the structure can be assumed to be a very deep beam with a curved flange.

The roof of the exhaustion chamber was designed in much the same way as the diffuser and collector, consisting of a series of three barrels having the same curvature but of different heights and widths, permitting one set of forms to be used throughout. Six frames, each consisting of a vertical and inclined leg, transmit the load of the roof and the 4 in. thick vertical walls to the foundation.

Each propeller housing, located in the parallel walls forming the end gable of the exhaustion chamber, contains a platform to receive the 1000 h.p. motor and propeller. This platform is supported on two inclined legs. The design of these frames was one of the most difficult and complicated problems encountered in the entire project.

Throughout the design of the whole structure, careful study was given to preventing vibration. This was accomplished to a large degree by the rigidity of the building and by stopping the parallel walls supporting the propeller housings about 5½ ft. below the intrados of the arched roof. The intervening space was closed with a glazed framework. As completed, the Chalais-Meudon Wind Tunnel is entirely original in form and exceptional in dimensions, and it constitutes a harmonious ensemble of perfectly balanced elements. The builders bent every effort to produce as homogeneous and simple a design as possible, and these are, indeed, the characteristics of the construction. The building reveals the adaptability and unlimited possibilities of concrete in the solution of a most difficult engineering problem.

The work was completed in about 2 years, using 45,000 cu. yd. of reinforced concrete, 18,000 cu. yd. of mass concrete, 700 tons of steel and many board feet of lumber for forms. Studies of the design required 560 blueprints.

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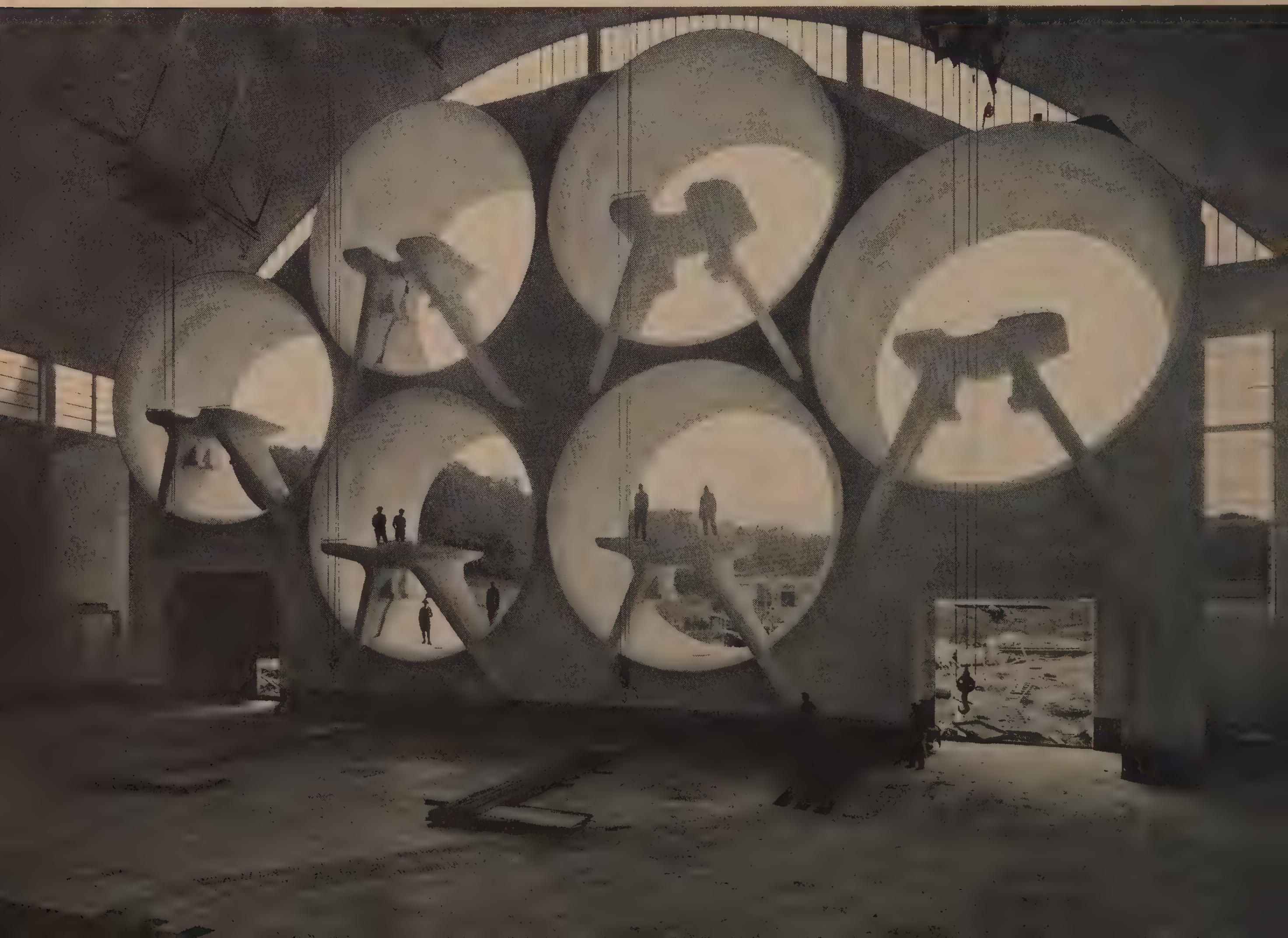
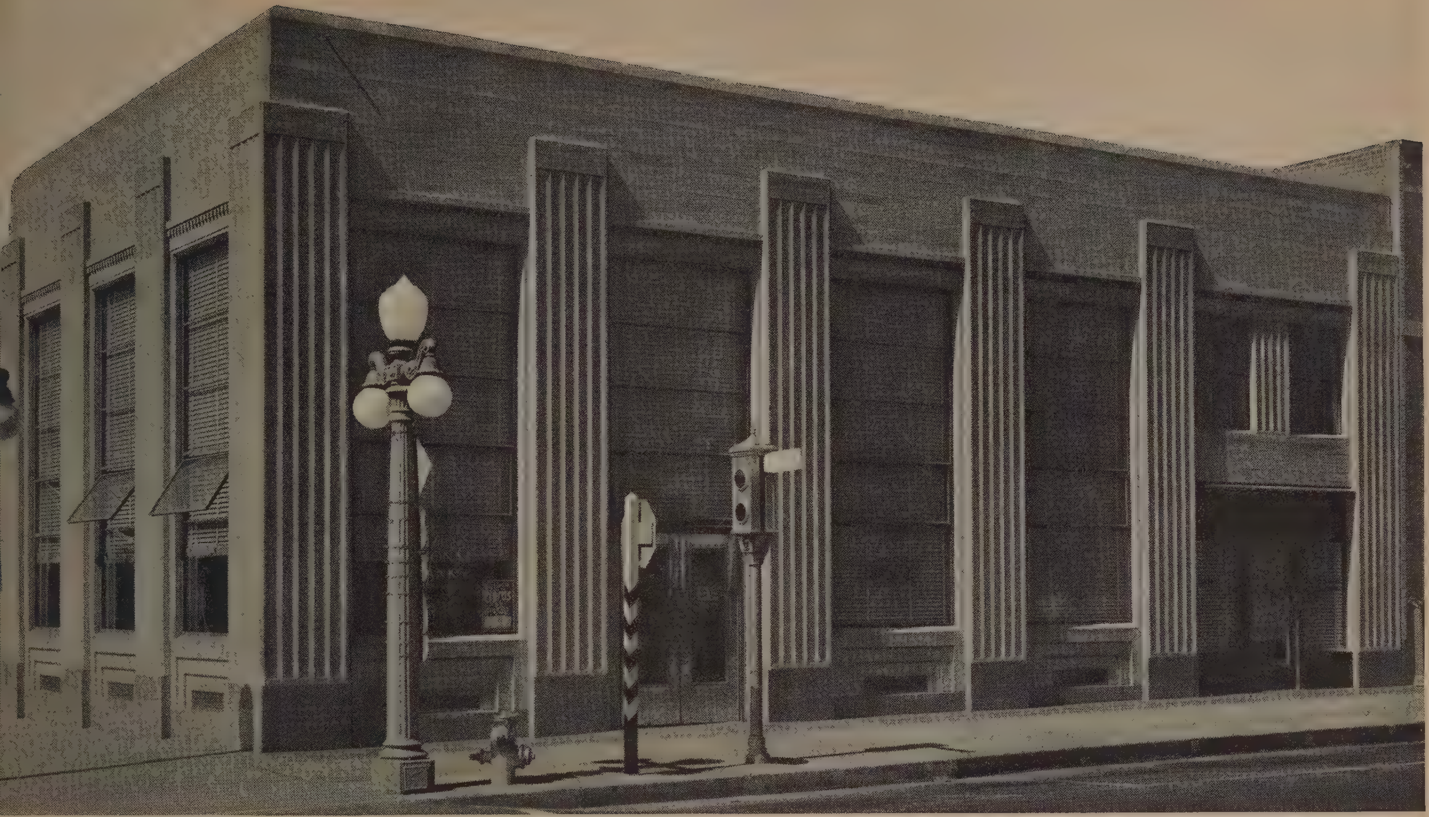
*This type of construction is commonly known in the United States as Z-D Barrel Shell Construction.



Each of the six propeller housings was built to support a motor resting on inclined legs of concrete. To resist the many stresses set up by operation of motors and fans, the housings were cast in parallel supporting walls. To avoid vibration of the superstructure, the gable walls were stopped about 5 ft. below the arched roof.



New home of Citizens' National Bank, Colton, Calif. An impression of height was given to this single story building by the use of tall windows and fluted columns. G. Stanley Wilson, architect, Riverside; Bakker and Robinson, contractors, San Bernardino.

Designing a Small Bank Building

By G. Stanley Wilson, A.I.A.

SMALL buildings often present design problems that are more interesting and sometimes more troublesome than those encountered in larger structures. The masses with which one must deal are not impressive simply by virtue of size. Dignity and grandeur are almost inherent in some of our modern immense buildings, achieved without close attention to detail. The small building has none of these advantages. It can be observed completely in one glance, which is a distinct disadvantage, requiring a more closely knit theme and a far more consistent scheme of ornamentation and detail than is necessary in the large structure. But in the main, the problem in the design of the small building is to give it importance, an appearance of height and, to a certain extent, mass.

The Citizens' National Bank Building, recently erected at the main intersection in the town of Colton, Calif., demonstrates the problem of small building design. A street widening program, in which building lots were reduced, necessitated the demolition of the previous structure occupying the site, and the new building was limited to 55x65 ft. in plan. Since the site is the most centrally located point in town, it was quite important that the new building be impressive, yet reserved and dignified as possible, and the fact that it was to be occupied by a bank suggested a structure of strong and rugged character. To achieve these desired effects in a one-story building was the problem.

The use of monolithic concrete without applied surface treatment is a favorite construction method in our office; hence, concrete was immediately selected as the material upon which to base the design. The adaptability of reinforced concrete to earthquake resistant requirements for all California structures was, of course, another important reason for the choice.

Architecturally, the building is a modern adaptation of the classic style, employing comparatively tall and wide pilasters. The fluting of these pilasters lends height to the building, and height in a one-story structure adds dignity to the whole design. The building is, however, higher than

To conserve space, the Board of Directors' room was placed above the vault. An acoustical plaster ceiling is hung on metal lath from the concrete roof. Walls are cream-colored cement stucco, the floors terrazzo in a contrasting shade.

most one-story structures, its 24-ft. height accommodating a high ceilinged banking room with a mezzanine floor at one end.

The fluting was accomplished with milled wood strips nailed to the inside face of the column forms. These flutes were made relatively wide in keeping with the scale of the building. The concrete in the pilasters was placed in one operation from sidewalk level to their tops where they terminate in the parapet wall of the roof. The joint between the roof spandrel and the pilasters was horizontal across the top of the columns and vertical at the sides extending down to the window heads. By this means, the joints were concealed in the angle where the pilasters project from the face of the spandrel. Ordinarily, the joint would have been carried horizontally through the column at the level of the window heads; but where this is done, it is somewhat difficult to conceal construction joints. The method of construction used eliminated this difficulty.

Concrete for the pilasters was deposited through an elephant trunk from roof level. This trunk, at the outset, was lowered practically to the bottom of the columns and at no time was the concrete allowed to fall free from a greater height than 3 ft. Practically perfect placement was obtained by this means. Recesses were left at the bottom of each pilaster for the application of a granite base. The granite used is grey flecked with black, somber enough in color so as not to detract or draw attention from the rest of the building, yet giving the appearance of solidity and strength.

Paneled recesses under the windows were formed with standard thicknesses of boards, and serve to break up the plain surface and reduce the area between the windows and the ventilators, which are of classic Greek design executed in white metal.

The dentil course emphasizing the classical tendency of the design was formed with wood. Concrete is ideal for the monolithic construction of dentils, or any other ornament for that matter; and because they are monolithic, their color, texture and durability are on a par with the rest of the building. It follows, naturally, that with such a strong medium as concrete, the windows should be of heavy metal sections glazed with plate glass. These openings have projected type ventilators which may be opened when required. Recesses were left in the sides of the pilasters to receive the metal windows, which were anchored and grouted into place and caulked against the concrete.

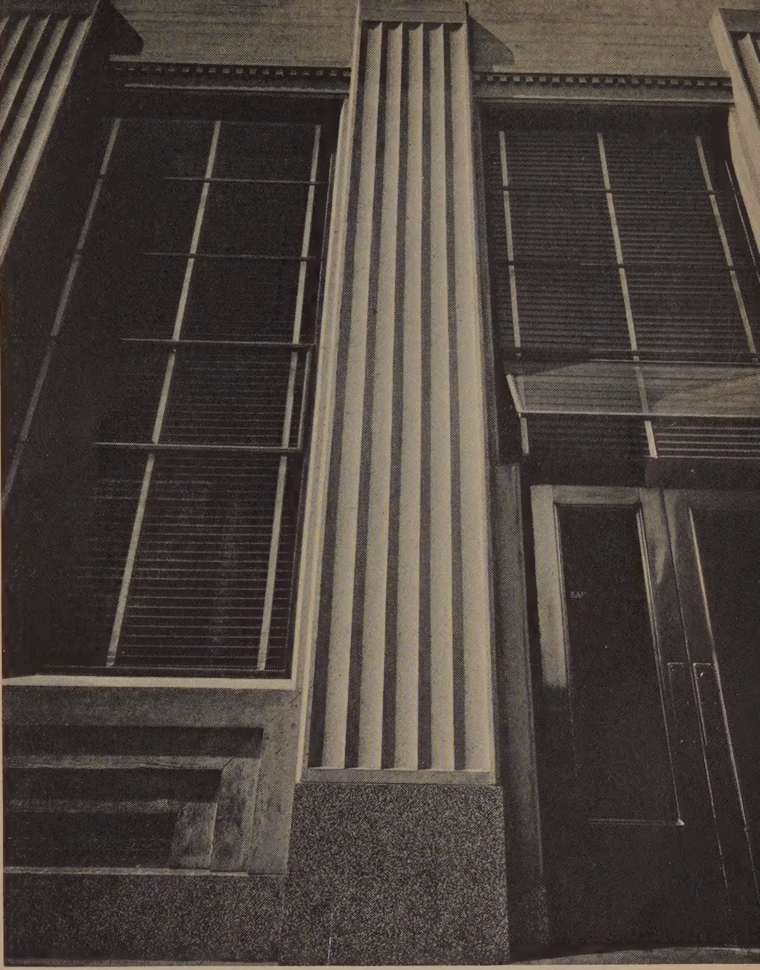
Due to the comparatively small size of the bank room, the directors' room was installed on the mezzanine floor over the vaults. This proved a very satisfactory solution, for it allowed maximum use of space and left more room for employes on the ground floor.

An acoustical plaster ceiling is hung on metal lath from the concrete roof. The walls are plastered with cream-colored stucco which contrasts pleasantly with the terrazzo floor. Interior furnishings are of dark mahogany.

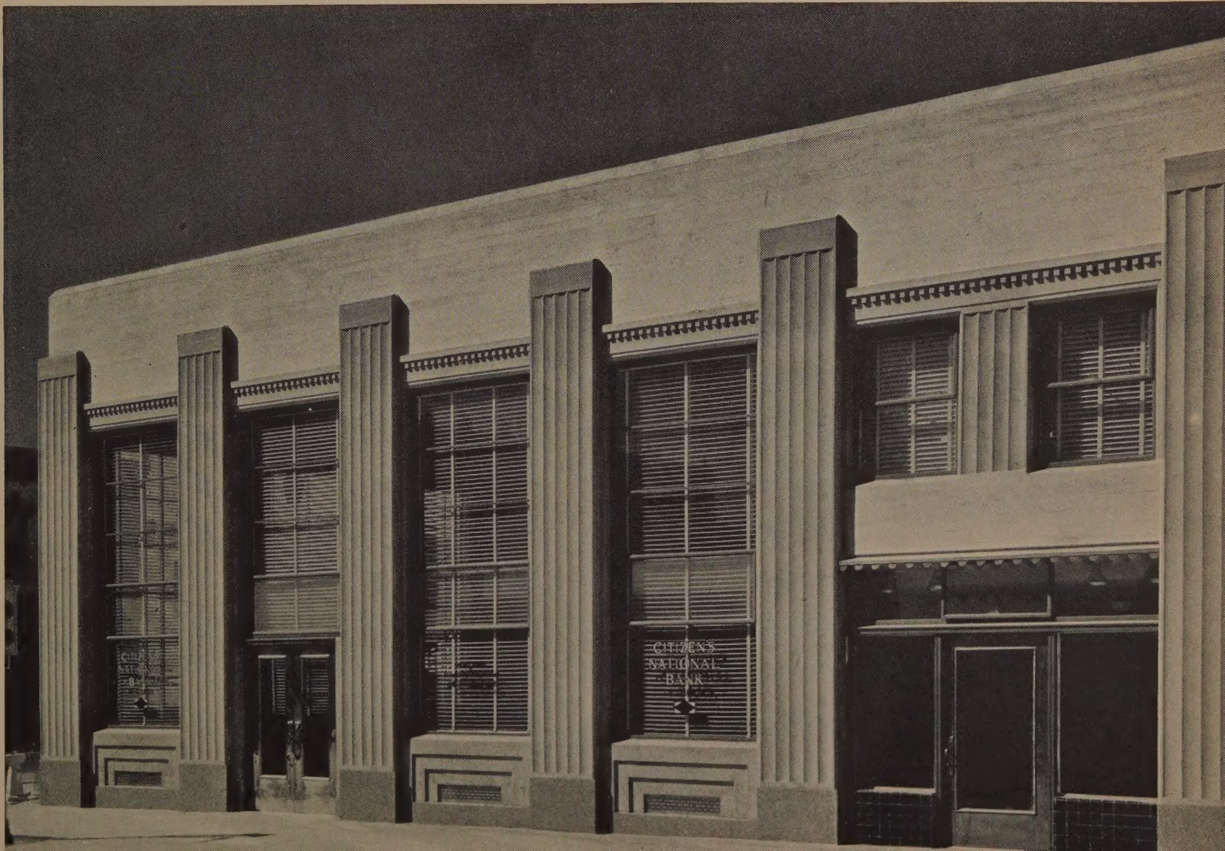
Concrete employed on the job was roughly a 1:2½:3½ mix by volume, with ¾-in. maximum sized aggregate. Each yard of concrete required 5½ sacks cement, no admixture of any kind being used. No more than 6 gal. water was used per sack cement. So it may be seen that a fairly stiff concrete was used which, however, was easily workable without vibration. All forms were held in place with pencil rods and the reinforcement was kept in position with steel spacers.

The finish of the building has been left in the neutral cement color, which, in this case, is a very light grey. We had contemplated giving the structure a coat of cement paint, but because of the very pleasant and uniform color and texture obtained, this additional surface treatment was deemed unnecessary. For this as well as for careful execution of the design, much credit must be given to J. N. Robinson, of the contracting firm of Bakker and Robinson, San Bernardino.

The building was erected in 90 days at a cost of $20,000.



The sharp detail of fluting and paneled recesses under the windows resulted from well designed concrete thoroughly spaded in the forms.



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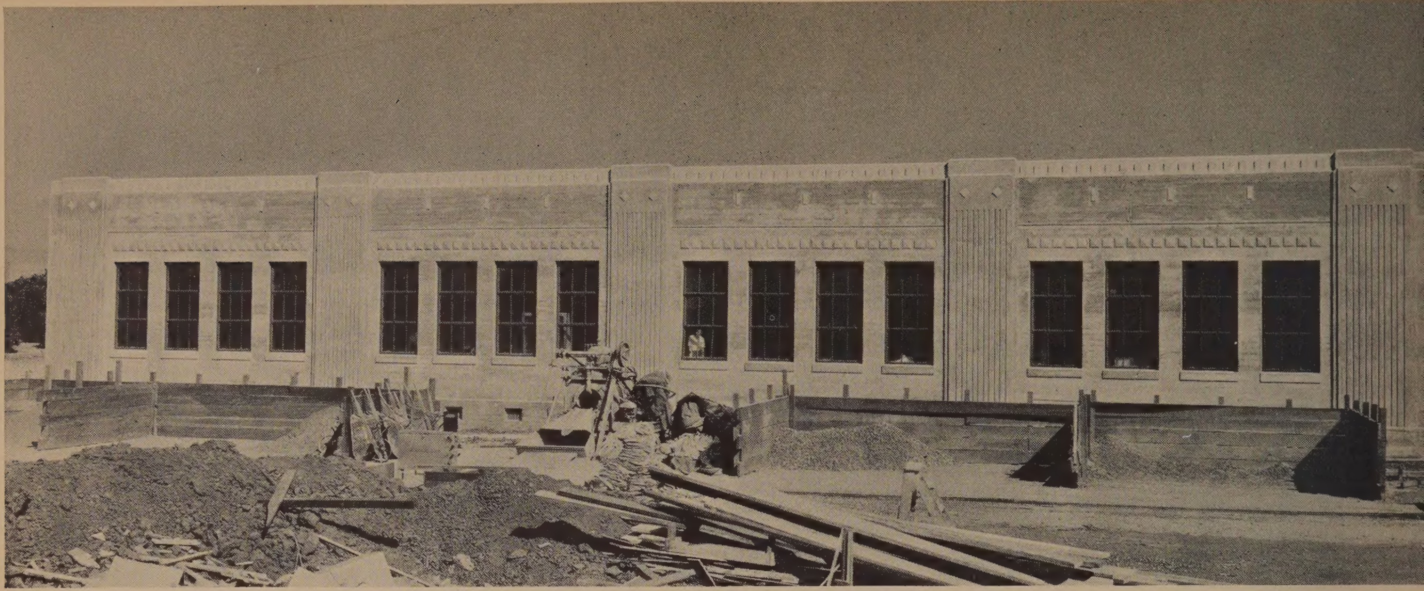

Valencia High School, Placentia, Calif., demonstrates layout of equipment for controlling concrete. Storage bins for various sized aggregates should be arranged near the scales and mixer, as shown above. T. C. Kistner was architect for this school.

Control for Architectural Concrete

By William T. Wright*

THE construction industry has been slow to adapt itself to controlling concrete on small building projects. Most larger projects are being rigidly controlled, usually with a considerable saving in cost. This same saving can be made on smaller projects and a much higher grade of concrete produced at the same time. Recently we had an opportunity to demonstrate this on three school projects. These were a classroom building and an auditorium on the site of the Norwalk School in Norwalk, Calif. and the Valencia High School in Placentia, Calif. Exterior walls and some of the interior walls are exposed concrete cast in forms using 1x6-in. tongued-and-grooved lumber and plaster waste molds for ornament.

For the classroom building of the Norwalk School, the contractor used transit mixed concrete. A job inspector, trained in the methods used by the California State Highway Department, was employed and an assistant inspector was placed at the proportioning plant where the trucks were loaded. Samples of aggregates were taken at intervals from the bunkers and tested for moisture content. Proper allowance for this moisture was made in adding water to the batch. The inspector on the job telephoned his orders to the proportioning plant, giving the necessary data for changes in the mix. While some difficulty was encountered at the beginning in co-ordinating the plant with the job, this was soon overcome and concrete of the required workability came rolling in on schedule.

For the auditorium building the contractor set up his own plant. Coarse aggregate was separated into three sizes and re-combined on the job. All concrete was vibrated and the resulting walls were found to be in almost perfect condition when the forms were stripped. On the Valencia High School, the materials, equipment and supervision were furnished by the School District. A competent superintendent and an expert concrete inspector were employed.

Designing mixes for these jobs and controlling the materials were greatly facilitated by weight measurement of the aggregates. The inexpensive equipment required was soon paid for by the savings made in the cost of materials, handling, placing and finishing the more uniform concrete.

Mixtures were designed by the absolute volume method. Approximate proportions were first assumed, based on experience with the materials. The percentages of the various sizes of aggregates were then adjusted to give the desired gap grading curve used by this office. The apparent specific gravities of the aggregates were then determined and by the absolute volume method the weight of each material for the batch was established. By this method an experienced designer can fix the mix so that no changes will be necessary in the field except to make corrections for variations in moisture and grading.

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*Structural Engineer for the office of T. C. Kistner, architect.

A "Dunagan"* apparatus was used for moisture and apparent specific gravity determinations. To determine apparent specific gravity, the aggregate was soaked for at least 24 hours, then surface dried by spreading it on a canvas and exposing to the sun until the surface moisture evaporated. The surface dry condition of sand is indicated when the sand will stand in a sharp cone on a spoon or will run freely through the fingers without leaving moisture. Coarse aggregate was wiped dry with cloths. The surface dry sample was weighed in air and then in water.

Mixing water must be measured for each batch if uniform control is to be expected. This was done consistently on these jobs. The water indicator dial on the mixer was carefully calibrated by setting the dial at a given point, discharging the water from the tank into a container and measuring the water. The easiest and most accurate method was to weigh the water, dividing the pound weight by 8.33 to reduce it to gallons. This operation was repeated for dial settings throughout the range of its capacity.

Each day the free moisture content was determined and the necessary changes made in the amounts of materials measured. Specifications for the Valencia job permitted 7½ gal. water per sack cement. To give some margin of safety, the mix was designed for 7 gal., which required 5 sacks cement per cu. yd. concrete. The materials used allowed a mix of 37 per cent sand, 9 per cent pea size, 9 per cent ¾-in. and 45 per cent 1½-in. coarse aggregate, or, in pounds by dry proportions for a 1-sack batch, 242.39 lb. sand, 58.96 lb. pea size, 58.96 lb. ¾-in. and 294.8 lb. 1½-in. rock. After making corrections for moisture content, the mix for one day was 252.5 lb. sand, 59 lb. pea size, 59 lb. ¾-in. and 295 lb. 1½-in. coarse aggregate. The average 28-day strength was 3,332 p.s.i. While the minimum strength specified was 2,000 p.s.i., the specifications would not permit an increase in the water-cement ratio, as this would produce a less durable concrete.

The three sizes of coarse aggregate and the sand were stored in four bins, two on each side of the mixer, and were measured separately. A four-beam platform scale was used for weighing the aggregates in the wheelbarrows used in charging the mixer. Wheelbarrows were loaded at the stock pile, run onto the platform and balanced at the proper weight. The men soon became so expert that they could estimate the proper weight within a shovelful or two. Small bins were placed on each side of the scale for materials used in making the necessary corrections.

Separated sizes of coarse aggregate must be re-combined in suitable proportions. With these particular sizes, good mixtures were produced with 10 to 25 per cent of the smallest size and with 10 to 50 per cent of each of the two larger sizes but, in any case, the proportions should be varied to give the desired workability. The relative cost of individual sizes may influence the proportions.

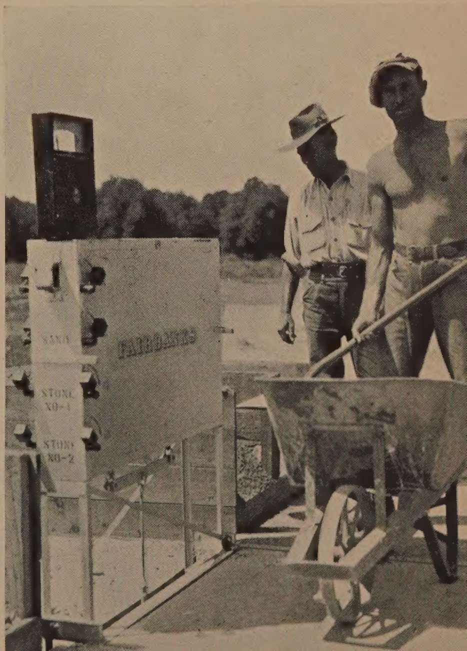
On the Valencia High School job, it was found that the use of internal vibrators permitted a considerably stiffer mix. The stiffer mixtures allowed more aggregate to be used with a given amount of cement paste.

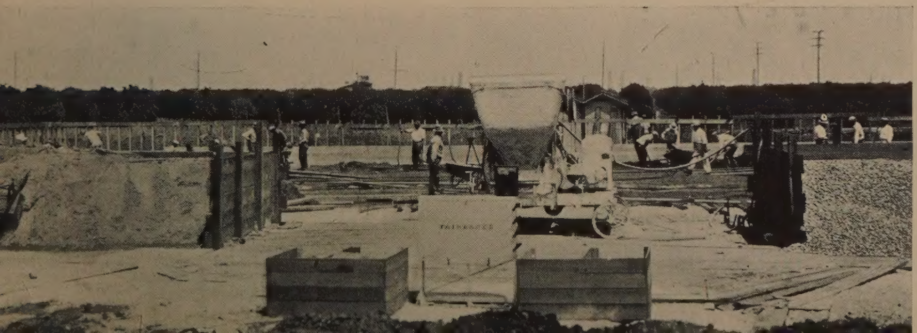
Workability is greatly affected by the grading of sand. It is particularly important to have sufficient of the fine particles. Specifications of this office require from 10 to 30 per cent of the sand passing the No. 48 mesh sieve. This gives from 2 to 10 per cent of the combined aggregate passing this sieve. On these three jobs, from 4 to 5 per cent of the total was of this size material.

The uniformity of concrete resulting from carefully controlled mixtures prevents the danger of surface honeycomb due to segregated concrete. Each batch is the same consistency. Combined with careful workmanship in handling and placing, such mixtures result in architectural concrete which meets the most severe requirements.

The results of the eight buildings on which this office has used architectural concrete have proven that it is not only economical but is flexible in design and construction. By proper arrangement of construction joint locations to coincide with design, and by the use of ornament set into the wall rather than extruded, simple pleasing designs of comparatively low cost have resulted. Particular attention has been paid to form construction, as the ultimate result depends greatly on this operation.

For speed and convenience in weighing materials, the scale is equipped with trips for cement, sand and the different sizes of coarse aggregate. Small bins near the scales hold enough material to make adjustments during weighing.





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*W. M. Dunagan, Assistant Professor, Civil Engineering, Iowa State College, Ames, Iowa.

Science Building for Hollywood High School. Marsh, Smith & Powell, architects; R. H. Annin, supervising engineer; Sarver and Zoss, contractors—all of Los Angeles. Frame, walls and floors, as well as sculptured panel, grilles and other detail cast integrally in concrete of rigidly-controlled quality.

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